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CONTROLLING THE FURTHER DEVELOPMENT OF NUCLEAR WEAPONS

A Collection of Excerpts and a Bibliography

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OF THE
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UNITED STATES SENATE

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FOREWORD

Last year, when the national high-school debate topic was "What Should Be the Nature of United States Foreign Aid?" the Foreign Relations Committee issued a collection of excerpts and a bibliography, prepared by the Legislative Reference Service of the Library of Congress, which proved very helpful in meeting the demand for information on this subject.

For the academic year 1958–59 the national intercollegiate debate proposition is "Resolved: That the further development of nuclear weapons should be prohibited by international agreement." To help meet the need for information on this topic, the Subcommittee on Disarmament of the Committee on Foreign Relations, of which Senator Hubert H. Humphrey is chairman, again asked the Legislative Reference Service to prepare an impartial compilation of excerpts and a bibliography. This collection of excerpts, which was prepared by them in consultation with the subcommittee staff, points out some of the principal points of view on the subject and the bibliography provides a guide to additional literature on the question. None of the excerpts or items included in the bibliography necessarily reflects the views of the Committee on Foreign Relations.

I hope that the collection will prove helpful not only to the student debaters but to the many others who are concerned about this complex problem which involves foreign policy, national security, morality, and many other considerations.

THEODORE FRANCIS GREEN, *Chairman.*

CONTROLLING THE FURTHER DEVELOPMENT OF NUCLEAR WEAPONS: A COLLECTION OF EXCERPTS AND A BIBLIOGRAPHY

INTRODUCTION

The following collection of excerpts was prepared in response to numerous inquiries from Members of Congress for materials on the subject of controlling the further development of nuclear weapons. The Senate Foreign Relations Subcommittee on Disarmament also specifically requested a compilation of excerpts on this topic, which is being widely debated this year by students in American colleges and universities.

In selecting passages for quotation, the goal has been to provide background information and samples of various points of view with respect to the subject. The compilation is intended to stimulate thought and discussion rather than promote any particular view. As a guide to some of the extensive materials which have been published on this subject, a select bibliography has been appended to the collection of excerpts.

Inclusion of a statement in this compilation implies neither approval nor disapproval by the Legislative Reference Service of any opinions expressed therein.

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HUGH L. ELSBREE,
Director, Legislative Reference Service.

I. POLITICAL AND STRATEGIC IMPLICATIONS OF THE FURTHER DEVELOPMENT OF NUCLEAR WEAPONS

CHALLENGE AND RESPONSE IN UNITED STATES POLICY

By John Foster Dulles[1]

Collective security must * * * be buttressed by military capabilities to deter armed aggression and to cope with it if it should occur. In December 1950, in an address before the American Association for the United Nations, I spoke to this problem, pointing out that—

> With more than 20 nations strung along the 20,000 miles of Iron Curtain, it is not possible to build up static defensive forces which could make each nation impregnable to such a major and unpredictable assault as Russia could launch. To attempt this would be to have strength nowhere and bankruptcy everywhere.

I went on to say:

> Against such military power as the Soviet Union can marshal, collective security depends on capacity to counterattack against the aggressor—

and I pointed to our Strategic Air Force and our stock of weapons as constituting an arsenal of retaliation.

During the ensuing years the military strategy of the free-world allies has been largely based upon our great capacity to retaliate should the Soviet Union launch a war of aggression. It is widely accepted that this strategy of deterrence has, during this period, contributed decisively to the security of the free world.

However, the United States has not been content to rely upon a peace which could be preserved only by a capacity to destroy vast segments of the human race. Such a concept is acceptable only as a last alternative. In recent years there has been no other. But the resourcefulness of those who serve our Nation in the field of science and weapon engineering now shows that it is possible to alter the character of nuclear weapons. It seems now that their use need not involve vast destruction and widespread harm to humanity. Recent tests point to the possibility of possessing nuclear weapons the destructiveness and radiation effects of which can be confined substantially to predetermined targets.

In the future it may thus be feasible to place less reliance upon deterrence of vast retaliatory power. It may be possible to defend countries by nuclear weapons so mobile, or so placed, as to make military invasion with conventional forces a hazardous attempt. For example, terrain is often such that invasion routes can be decisively

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[1] From Challenge and Response in United States Policy. Department of State Bulletin, vol. 37, October 7, 1957, pp. 569–579.

dominated by nuclear artillery. Thus, in contrast to the 1950 decade, it may be that by the 1960 decade the nations which are around the Sino-Soviet perimeter can possess an effective defense against full-scale conventional attack and thus confront any aggressor with the choice between failing or himself initiating nuclear war against the defending country. Thus the tables may be turned, in the sense that, instead of those who are nonaggressive having to rely upon all-out nuclear retaliatory power for their protection, would-be aggressors will be unable to count on a successful conventional aggression but must themselves weigh the consequences of invoking nuclear war.

* * * * * * *

As nuclear weapons come to provide greater possibilities for defense, this will require changes in military and related political strategy. So long as collective security depends almost wholly upon the deterrent of retaliatory power and the ability to wreak great destruction upon an aggressor nation, there has to be almost sole dependence upon the United States. No other nation can afford the cost of maintaining adequate deterrent power.

* * * as nuclear weapons become more tactical in character and thus more adaptable to area defense, there will inevitably be a desire on the part of those allies which are technically qualified to participate more directly in this defense and to have a greater assurance that this defensive power will in fact be used. Such factors are already leading to study of a so-called atomic weapons stockpile which could be established by the United States in the European NATO area and, as becomes appropriate, made available to NATO.

A concomitant of this problem is how to prevent the promiscuous spread of nuclear weapons throughout the world. Without safeguards, such weapons might in the future get into the hands of irresponsible dictators and be used as a form of international blackmail. The world would indeed become an unhappy place to live in if humanity had to accept an ever-present threat of this character.

We are only beginning to envisage the drastic changes in political-military relations which will be consequent upon the rapid growth of scientific knowledge and operating experience in the nuclear field. New weapons possibilities are opening up in rapid succession. Political thinking finds it difficult to keep up with that pace. And, of course, there is inevitably some interval between the thinking and the institutionalizing of the results of thinking.

The development of a common defense has meant, and will continue to mean, heavy outlays for an effective and modern United States Military Establishment. It has also required, and will continue to require, the United States to give military assistance and support to the military forces of those nations associated with us in collective arrangements or in special need or danger. Such assistance is in no sense to be viewed as charity. It is based on a hardheaded appraisal of our own defense needs. Without it, our own defense costs would be far greater and our security far less. The aggregate military and economic resources of the free world coalition represent the greatest and least costly insurance against war. * * *

The United States recognizes that armaments alone are no lasting guaranty of peace. We are, therefore, pursuing a policy designed to set up safeguards against surprise attack and to bring national armaments, both nuclear and conventional, under effective international

limitation and supervision. It is true that so-called disarmament efforts in the past have proved futile. The Hague Peace Conferences, the Versailles Treaty, the Washington Naval Limitation Agreement, the League of Nations Disarmament Conferences are recent conspicuous examples of failure. But there are important differences today.

Past efforts have usually proceeded from the assumption that it is possible to establish and maintain certain defined levels of military strength and to equate these dependably as between the nations. Actually, military potentials are so imponderable that this always has been and always will be a futile pursuit. Today there is a new approach. It is proposed to establish a system of international supervision which will make massive surprise attack unlikely. If this happens, then general war becomes less likely and the level of armaments will almost automatically go down.

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The most important difference from the past is, of course, the fact that never before has there been such need to reduce the risk of war. Today a general war between the great military powers could destroy almost all human life, certainly in the northern latitudes. Our working hypothesis must be that what is necessary is possible. We assume that the forces which man has created man can, by wisdom, resourcefulness, and discipline, harness and control. We persevere in common efforts to free the world from the continuing threat of destruction by the weapons that its civilization has produced.

THE NEED FOR DISARMAMENT

By the Senate Foreign Relations Committee Subcommittee on Disarmament [2]

The need to make progress on controlling and reducing armaments is more apparent today than ever before. No one would dispute that the discoveries and inventions of science in the last decade have produced weapons which are so destructive that the human mind can hardly contemplate what the world would be like if they were used in war. The atomic bomb used in 1945 on Hiroshima was a 20-kiloton bomb, the equivalent of 20,000 tons of TNT. It caused 150,000 casualties in an area of 5 square miles. This weapon was then the most destructive the world had ever known. Today, however, the Hiroshima and Nagasaki bombs are small as compared to the largest weapons in our stockpile. In 1954, nuclear weapons tests of the United States revealed that 1 explosion contained a blast that was vastly greater than the bombs used 9 years earlier. Possession of nuclear bombs now resides in the Soviet Union and the United Kingdom as well as the United States. Furthermore, the radiation resulting from these large bombs would cause damage not only to the thousands of people in the immediate vicinity of the explosion but perhaps would cripple and maim future generations.

Some military and political leaders have found consolation in the great firepower of the new weapons. They have reasoned that when

[2] From report of the Committee on Foreign Relations Subcommittee on Disarmament, September 6, 1957. U. S. Senate, 85th Cong., 1st sess. Washington, U. S. Government Printing Office, 1957: pp. 3–9.

war becomes so brutal for all sides, nations will be reluctant to commit aggression for fear an attack would spread both in area and in type of weapons used. Thus, the concept of nuclear deterrence has grown and has been considered to date one of the chief elements in the preservation of world peace.

Nuclear deterrence as a means of maintaining our national security has its limitations. One definite limitation is that the number of countries with nuclear weapons in their possession will undoubtedly grow. At present only three countries manufacture them. It is not known whether the U. S. S. R. has loaned or given these weapons to other countries but the United States and the United Kingdom thus far have not. But other nations are quickly gaining the knowledge with which to produce fissionable materials and some already have the industrial capability to manufacture them. As nuclear weapons are spread throughout the world the likelihood of their use in war increases.

The idea of nuclear deterrence implies a degree of rationality. It assumes that the leaders of a government realize that their own country cannot escape the catastrophe of nuclear war and that, consequently, they strive to prevent it from occurring. If nuclear weapons are possessed by many countries with different types of governments, the element of rationality would be reduced. In some cases, there might be the temptation to use such weapons without due concern for the consequences.

Another drawback of the reliance on nuclear deterrence is the advancement of military technology. The large powers, particularly, are engaged in an unending race for weapons; weapons not only growing in destructiveness but against which there is little or no defense. Thus, there exists today a race to produce an intercontinental ballistic missile which will transcend continents at a speed of 15,000 miles per hour and once launched will land at its destination in a matter of minutes. The Soviet Union has just announced that it has successfully tested such a missile and the United States is working toward that end. With such weapons in the arsenals of the major powers, even a small mistake or miscalculation could embroil the world in an all-out holocaust. The fact that these missiles are being perfected make disarmament of the greatest urgency.

Finally, an indefinite race for military superiority among nations constitutes a tremendous use of resources. For example, about half the research carried on in the United States is for military purposes. * * * In the Soviet Union a large percentage of the production of basic raw materials goes into the manufacture of weapons. Production of items for defense increases the cost of living. Diversion of vital goods and services year after year into nonconstructive projects hinders people everywhere from enjoying a better and more prosperous life.

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RELATIONSHIP OF INTERNATIONAL TENSION TO ARMAMENTS

The subcommittee, in its study of disarmament, found that two basic approaches are offered to halt the armaments race. One approach considers that armaments are primarily a symptom and not a cause of the existence of international tension. According to this

approach, before armaments can be reduced the disputes must be settled and the tensions must subside. Negotiations on armaments reduction and control are thought to be fruitless until political disputes are resolved; arms reduction would thus follow automatically. If political differences cannot be worked out then it is considered futile to expect that the arms race can be halted.

A second basic approach differs from the above in that it adopts the premise that armaments are often a cause of tension and not merely the result of it. Proponents of this approach believe that efforts to reduce armaments must be attempted irrespective of progress on solving political questions. According to this argument, nations must learn to settle their differences through peaceful means and not through war. Proper arms-control measures, in addition to reducing the burden of armaments, may promote the settlement of outstanding political issues by creating a more temperate atmosphere.

It is the view of the subcommittee that these two approaches should not be considered mutually exclusive. Each has validity. It is not necessary to choose one above the other, but to decide the extent to which the two approaches may be pursued simultaneously, how far progress in one area can be made without corresponding progress in the other, and whether the methods by which the two approaches are sought may be independent or must be joined.

There is no single road to peace. Many paths must be explored. Reducing international tension and diminishing the threat of war should be pursued both through efforts to settle political problems and through negotiations to curtail and control armaments. Neither approach alone, in the opinion of the subcommittee, is sufficient.

Substantial reduction of armaments cannot be made without corresponding progress on the resolution of at least some political issues. Nations have yet to adopt and follow common standards of international behavior. Therefore, the possession of armaments is still considered to be a principal means of protecting a country's vital interests.

On the other hand, to await the solution of all political problems before proceeding to attempt the control of armaments is unrealistic and can be dangerous for the future security of this country and, indeed, the world. It is unrealistic, because many of the political problems confronting the world today are so basic that solutions, if they come about at all, can only occur gradually. It can be dangerous, because as time goes on the armaments race is continued at an accelerated pace, and the threat of nuclear catastrophe becomes more acute.

In the view of the subcommittee the conflict between the free democratic world and the Communist totalitarian world is too fundamental to expect a settlement within the foreseeable future. We cannot blind ourselves to the persistence, if not permanency, of the Communists' quest for world domination. What we must try to do is to diminish or halt the arms race on the premise that limited and safe measures will in themselves help to reduce world tension.

It appears to the subcommittee that some of the outstanding political problems are impeding substantial progress on disarmament. That is, before the armaments of the United States and other powers can be reduced beyond a limited amount some progress must be achieved on these political problems.

STRATEGY OF SWORD AND SHIELD

By Maxwell D. Taylor [3]

Strategy has long been historically related to the conduct of war and only rarely associated with the conduct of peace. However, in this period of world tension, we in uniform take as our objective, first and foremost, a strategy of deterrence—a strategy for the prevention of war.

It requires no eloquence on my part, I am sure, to convince you of the necessity of creating conditions which will make general atomic war impossible, or at least highly improbable. It is an inescapable fact that a megaton nuclear conflict would bring irreparable disaster to all participants. In such a war no true victor could emerge. Hence, our strategy and efforts are directed toward the prevention of this disaster; it must never be allowed to occur.

Because of the suicidal nature of general nuclear war, it appears increasingly unlikely that any nation will deliberately embark on such a war. However, that conclusion does not necessarily mean that international communism will renounce armed aggression as a tool of policy. There is strong reason to feel that while avoiding general atomic war, communism will incline toward limited aggression, infiltration, subversion, and the like—courses of action which appear as increasingly serious threats to world peace. These forms of aggression, if not arrested, may lead to the erosion of the free world and to our loss, piecemeal, of that which we are pledged to defend. If resisted, they must be resisted promptly and successfully, for otherwise the contagion would spread. Consequently, immediately after the deterrence of general war, I consider the mission of deterring, or winning quickly any local aggression an indispensable part of our security.

Thus, in my judgment, the effectiveness of our national strategy and our Armed Forces must be judged by the contribution, actual or potential, to the deterrence of war. This very practical consideration bears upon the conduct of our daily military business in the Pentagon. Within the Army, for example, everything which we do is examined in terms of its contribution to deterrence.

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This concept of the dual role to be performed by our Armed Forces can be illustrated best by consideration of the military situation in Western Europe.

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Our overall strategy in Western Europe has been to station ground forces as a shield across Western Europe, capable of resisting a surprise attack and of holding the enemy at arm's length long enough to permit the application of the destructive power of our retaliatory forces. * * *

Thus the ground forces and supporting air forces are the shield required to obtain time in case of general attack in Western Europe. The sword is represented by the United States and Allied Air Forces which with their bombers and missiles have the mission and the means to destroy the aggressor while his progress is being held up on the

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[3] From Strategy of Sword and Shield. Signal, vol. 12, April 1958, pp. 5–6. General Taylor is United States Army Chief of Staff.

ground. Thus, the safety of Europe will depend on the successful interplay of sword and shield forces—both indispensable to our general war strategy.

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In a period of mutual deterrence, our air retaliatory sword tends to become a shield protecting us from the atomic sword of our potential adversary. The possession of our sword prevents him from using his sword tempered for a similar purpose. At the same time, the Army and tactical Air Forces of the kind which constitute a shield in Western Europe now assume a new importance in the role of mobile strategic forces capable of rapid intervention to resist local aggressions. To perform this important task, these forces must be constantly ready for strategic movement to any threatened point in the world. They must be equipped with the most modern equipment and capable of acting with or without atomic weapons as the situation may require. It is properly said that in the American Army atomic weapons are now conventional weapons and organic parts of our unit equipment. Nonetheless, we recognize that there may be limitations imposed upon their employment. In most of the hypothetical situations in which we consider it possible that we may use our land forces, we would be fighting in friendly countries to aid an ally. Under these conditions atomic weapons would have to be used with great care and discrimination to avoid great damage to those whom we wish to assist.

TURNING POINT FOR DISARMAMENT

By Hubert H. Humphrey[4]

Much of the controversy over inspection could be allayed if two principles were kept in mind. First, there must be an inspection system which is effective and adequate. We could not permit ourselves to be drawn into an agreement under which we would deprive ourselves of an important weapon in our armory while the other side secretly continued to arm itself with that weapon. Such a situation would not contribute to peace and would only hasten the conflagration we are trying to avoid. Inspection has to be good enough so that every country knows there is a great probability it is going to be caught if it tries to cheat on the agreement.

As long as an inspection system possesses this amount of certainty, we would have a high degree of assurance that no signatory of a suspension pact would run the political risk of sneaking an illegitimate test explosion. The military advantage it might get from a sneak test under such conditions would probably be so limited it would be far outweighed by the political disadvantages of getting "caught in the act" and thus ignominiously causing termination of the agreement, incurring the opprobrium of world public opinion, and, most important, causing the arms race to continue unabated.

What the perfectionists overlook is that there is a risk in whatever course we take. The second principle, therefore, is that there must be a balancing of risks between one course of action and another.

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[4] From Turning Point for Disarmament, the Progressive, vol. 22, August 1958: pp. 5–7. Senator Humphrey, of Minnesota, is the chairman of the Subcommittee on Disarmament of the Senate Committee on Foreign Relations.

This is the way we usually solve the problems of life. In disarmament we must weigh prudently all the dangers of continuation of the nuclear arms buildup toward an unpredictable climax against the risks that might be involved in a suspension of tests with an inspection network. We must balance the danger of spreading nuclear weapons know-how to fourth, fifth, and innumerable other countries against the danger that the U. S. S. R., which has, according to public reports, made about 50 tests to our approximately 100, might try to sneak a few more.

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The really significant thing is to get a test ban in effect and an inspection system in operation. Installation of an inspection system would be a political breakthrough of momentous proportions. It could be a landmark of the greatest historical importance in free world-Communist relations, a turning point toward peace in our time. Opponents of a nuclear test ban often miss this vital political factor.

The arguments for continuing tests to develop defensive weapons against enemy intercontinental missiles or for small clean tactical weapons to limit the threat of all-out nuclear war may be justified within a purely military frame of reference. But such a frame of reference is much too narrow. A purely military frame of reference will sooner or later eventuate in a purely military result.

Our frame of reference must encompass broader considerations, in particular the acceptance of the fact that differences between the Communist bloc and the democratic West must be resolved through peaceful competitive coexistence. History teaches that the most antagonistic ideological opponents have an interest in survival, and sooner or later learn to reach a peaceful modus vivendi. This is why disarmament is primarily a political rather than a military problem. This is why an inspection breakthrough into the Soviet Union outweighs the military value of the development of new varieties of nuclear weapons.

Those who insist that a cutoff of nuclear weapons production be linked to a nuclear test suspension should be more perceptive of the political realities and view this whole problem of disarmament in more of a time perspective. A temporary inspected test termination would constitute a natural step toward a prohibition of nuclear arms production.

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Both supporters and opponents of a temporary nuclear test suspension should realize that it would be only a beginning. It is only the first phase of our total disarmament blueprint. As a test ban comes closer to realization, we must stress our purpose of progressing to other phases of arms control; otherwise the momentum we desire as one of the main effects of the ban might be lost. By pressing inexorably onward to bring into operation a nuclear weapons test suspension and the rest of our disarmament blueprint, we shall bring closer the day when we can rid the world of its burdens of fear, hate, and want. The inauguration of a test ban now could start the wheels of international reconciliation turning and initiate a movement that will eventually bring genuine peace to the troubled peoples of the world.

RATIONAL NUCLEAR ARMAMENT

By Thomas E. Murray [5]

For several years you have heard me urge the need for rationality in our armament program. By rational nuclear armament I have consistently meant the creation of the whole spectrum of weapons capabilities that, under the control of sound military doctrine, will enable us successfully to meet the whole range of possible or likely Soviet military action. Essentially, the problem is to achieve in our production programs and in our resultant nuclear stockpile the right balance—a balance that will give us appropriate weapons strength both to support the rigid strategy of deterrence and also to give substance to a flexible doctrine of limited war.

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Even a balanced stockpile will not provide us with total security. But only a balanced stockpile will protect us against impalement on one or other horn of the nuclear dilemma—sudden destruction or slow defeat. Of the two alternatives, the latter presents the more likely danger. And it was against this danger that I have urged the imperative necessity of moving the small-weapons program out of the development phase into the phase of large-scale production.

* * * * * * *

Three particular misapprehensions, widespread among the public, call for immediate and official correction.

First, the impression has been created that widespread hazard from fallout is not a necessary complement to the employment of large bombs today. As a consequence it is believed that the radiation hazards of nuclear war have already been substantially lessened. This belief is not supported by the facts.

A second misapprehension concerns the possibility of satisfying our need of small weapons by making the big ones into small ones. In point of fact, a policy of making big ones into small ones is not practical. A thermonuclear bomb is not a sort of thousand-dollar bill that can be cashed into smaller denominations in any way one wishes.

The third misapprehension concerns the fallout dangers from small nuclear weapons. These dangers have been greatly exaggerated in the public mind. The crude misconception prevails, stimulated by certain statements that have been made, that a limited war fought with tactical nuclear weapons would result in radioactive hazards that would be pretty much as intolerable as the hazards resultant from the use of large weapons in a more or less allout war. There is the further misconception that testing small weapons is pretty much as dangerous, from the standpoint of fallout hazards, as testing large weapons. (Therefore—the people conclude—all kinds of tests ought to be stopped, for the same reasons.) Behind both of these misconceptions lies the strangely persistent failure to grasp the central fact that an essential difference obtains between the fallout from a kiloton bomb and the fallout from a giant megaton bomb.

[5] From report of Thomas E. Murray to the Joint Committee on Atomic Energy shortly before his retirement from the Atomic Energy Commission. In Extension of Remarks of John W. McCormack, Congressional Record [daily edition], July 2, 1957, pp. A5276–A5279.

The difference is really twofold. The first difference is easily illustrated. Nuclear tests thus far have released radioactive products from about 50 megatons of fission energy. You could explode 50,000 ground bursts of one kiloton each, and you would not have released more than this same amount of radioactive products. Note that 50,000 one-kiloton bombs would be enough to fight a fair fistful of limited wars, given the fact that this kilotonnage is some 30 times the total bomb tonnage dropped in World War II. In contrast, the explosion of five bombs as ground bursts, each releasing 10 megatons of fission (hardly enough for a total war) would immediately give you about the same amount of radioactive products that has been released in tests. The difference in the bombs, and in the wars into which they would fit, is immediately apparent.

Secondly, the fallout from kiloton bombs is far more subject to control than the fallout from multimegaton bombs. In a real sense the latter fallout is uncontrollable. Some of the radioactive products are shot into the stratosphere; then the laws of nature and not any human decisions dictate the worldwide coverage of the fallout. In contrast, the fallout from a one-kiloton bomb is far less in quantity and far more localized in extent. This is the reason why tests of kiloton devices can be conducted safely in Nevada; whereas tests of multimegaton devices can only be held in the Pacific proving grounds. Again the difference in the weapons, and their divergent usefulness in war, are apparent.

NUCLEAR TESTING AND THE PROBLEM OF PEACE

By Henry A. Kissinger [6]

The hopes which have been focused on a nuclear test ban are intense and varied. Many thoughtful people concerned about the danger of radioactive fallout maintain that the quest for security must not be allowed to endanger the health of future generations. Others argue that the end of nuclear testing is essential to build confidence for more fundamental agreement, especially in the field of disarmament. It would prevent the diffusion of nuclear weapons to other powers. It would lessen the dangers of thermonuclear wars. And these arguments are reinforced by an insistent Soviet campaign to the effect that nuclear tests should be unconditionally prohibited and nuclear weapons outlawed.

The yearning for an end of the cold war reflects the deepest aspirations of the free world. So intense is it that we have been ready to stigmatize as more immoral than other weapons the weapon around which we have built our defense of that world. But the very intensity of our desire for peace may increase our peril. It may make us seek agreement for its own sake and thus set in motion a train of events which will divide the non-Communist world and undermine its resolution.

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Certainly the free world has a duty to seek to spare mankind the horrors of another war. It must strive for any agreement that offers

[6] From Nuclear Testing and the Problem of Peace, Foreign Affairs, v. 37, October 1958: pp. 1–16. Dr. Kissinger is associate director of the Harvard Center for International Affairs and author of Nuclear Weapons and Foreign Policy.

such prospects. But a real relaxation of tensions can come about only if the Soviet leaders become convinced that they cannot use negotiations to induce us to disarm unilaterally, that any agreement must be mutually advantageous. We must consider, then, whether insistent Soviet demands for a complete ban on nuclear testing are not designed to paralyze the free world rather than to bring about peace as we understand the word. * * *

Rightly or wrongly, the free world has based its defense on nuclear weapons. We need not here review the circumstances nor analyze the motives that led to this decision. It is enough to note that nowhere in the Western World are there sufficient conventional forces to resist the Soviet preponderance in conventional strength; and nowhere is there any immediate prospect of developing them. Nothing now stands in the way of Soviet domination of Eurasia save the Soviet reluctance to pay the price of a nuclear war.

That is why the Soviet Union has systematically sought to paralyze the West's will to use the weapons around which its entire defense effort has been built. It has done this both by creating a substantial nuclear stockpile of its own and by seeking to have nuclear weapons outlawed. Appealing to the most basic fears of humanity, the whole apparatus of Soviet policy, from diplomacy to "peace" congresses, has sought to undermine our reliance on the most effective—or at least the only available—means of resistance to Soviet domination.

The free world should, therefore, have no illusions about the implications of a complete ban on nuclear tests. For if a cessation of nuclear testing is a first step to anything it is to an increased campaign to outlaw nuclear weapons altogether. If these weapons are too dangerous to test, so the argument will go, they are surely too terrible to use. That this is the aim of Soviet policy was made explicit by Khrushchev:

> After the termination of nuclear weapons tests, it would be possible to raise the question of the powers making a solemn undertaking not to use hydrogen and atomic weapons and henceforth to adopt a decision on the total prohibition of nuclear and thermonuclear weapons. * * *[7]

In the present state of western defenses such a prohibition is tantamount to unilateral disarmament.

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Would not the end of nuclear testing avoid the diffusion of nuclear weapons among other powers? * * *

The situation with respect to nuclear sharing can be summarized as follows: The Communist bloc possesses a decisive military superiority in all contiguous areas. The Soviet Union can threaten with nuclear weapons all peripheral areas and much of Africa from its own territories; Communist China is overwhelmingly stronger than any neighboring state in conventional weapons. In these circumstances the Soviet Union may have decided that it has little to gain and a great deal to lose from the diffusion of nuclear weapons. Indeed, in view of the political unreliability of some of the satellite regimes, it probably has a positive interest in keeping nuclear weapons out of their hands.

The immediate Soviet objective is, therefore, to prevent the development of a nuclear capability under local control on the European Continent, for then Western Europe and other contiguous areas will even-

[7] The New York Times, June 29, 1958.

tually become neutralized. Without a nuclear capability of its own, Europe will find it impossible to resist the increasingly bold Soviet threats of nuclear warfare, which have been a cardinal aspect of Soviet diplomacy in every crisis since Suez. Europe, should it want to be defended, would then become entirely dependent on the American assessment of its danger. In such a situation the Soviet leaders may well calculate that the United States would be reluctant to invoke its own destruction for the defense of Europe, or that even in an all-out war they could not be prevented from seizing Europe. For after the initial exchange of blows the Soviet Union would remain supreme in Eurasia.[8] That the Soviet Union is concerned with making Europe impotent and not with the threat offered by a European nuclear establishment is demonstrated by the Soviet protest against the plan to equip the Swiss army with nuclear weapons.[9] By no stretch of the imagination can Switzerland be suspected of aggressive intent against the U. S. S. R.

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If we permit a distinction to grow up between our Military Establishment and that of our NATO allies, our expulsion from Europe is almost inevitable. Further delay in the distribution of nuclear weapons to our European allies will give the Soviet Union more time to persuade Europeans that they will be able to escape involvement in any conflict by refusing to permit nuclear installations on their territory. Logically, this denuclearization of Europe will be followed by a demand that American troops withdraw, since their equipment is so obviously nuclear. At the very least it will expose us to great pressure to withdraw all our nuclear installations from the continent. Western Europe would then be impotent, at the mercy of Soviet Russia. NATO would cease to have meaning.

This is not to say that Europe must obtain nuclear weapons from its own production or that these weapons must be under national control. From many points of view it would be highly desirable if NATO's nuclear components were under NATO control, or if a European atomic force were formed on the model of EDC. Similarly it is not essential that nuclear weapons be locally produced, but only that there be European participation in their use and control. Before we go much further in the direction of a complete ban on testing, we should at the very least amend our Atomic Energy Act to permit wider nuclear sharing. And our approach to the question of nuclear testing should be based on premises which do not inhibit nuclear sharing and which will not give impetus to Soviet ban-the-bomb propaganda.

Will not the possession of nuclear weapons by our allies increase the danger of war? This would be true if our allies felt thereby encouraged to attack the Soviet Union, or if they were to use nuclear weapons in their own quarrels outside of Europe. But excessive adventurousness vis-a-vis the Soviet Union can hardly be considered a European failing. Even in the less preferred contingency that nuclear weapons were under national rather than NATO control, it is difficult to conceive the circumstances which would induce any Euro-

[8] See Peregrine Worsthorne, Our Bomb and Theirs: As the Russians See It, Encounter, July 1958. Also Raymond L. Garthoff, Soviet Strategy in the Nuclear Age, New York: Praeger, 1958.

[9] The New York Times, August 9, 1958.

pean country to unleash a unilateral attack on the Soviet Union. The individual nuclear capability will remain so small, the disproportion in vulnerability is so great, that they could not, by any rational calculation, use these weapons for offensive ends. Their purpose would be to make the costs of aggression, particularly of local adventures, prohibitive, and to discourage Soviet atomic blackmail.[10]

As for the use of these weapons to settle private quarrels outside Europe, this could be effectively forestalled by placing them under NATO or an overall European control. But even should they be under national control, the likelihood of their use outside of NATO is slight. The difficulty which the French Army has in Algeria is not inadequate firepower but that of finding targets against which this firepower can be used. Atomic weapons have little significance in guerrilla-type operations.

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To be sure, the more nuclear powers exist the more difficult it will be to arrest the spread of nuclear weapons. But we must weigh this risk against the danger of collaborating with the Soviet Union in the neutralization of Europe. This would leave us without powerful allies. It would place us ultimately in the position of having to defend the whole Soviet periphery alone against Soviet nuclear attack or Soviet atomic blackmail. Bilateral negotiations with the Soviet Union to the exclusion of our European allies are fraught with danger. It would be much better to deal with the problem of the diffusion of nuclear weapons directly rather than through the indirect method of a test ban, and to include our NATO allies as nuclear powers in any agreement, preferably through a European Atomic Community.

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In the negotiations on a nuclear test ban which are about to begin, the United States should therefore propose that we are willing to address ourselves immediately to the problem of fallout but that a complete ban would depend on a comprehensive disarmament agreement. Pending such an agreement, we should propose that, while nuclear weapons are essential to the defense of the free world, we are prepared to take immediate steps to mitigate the effects either of testing or of using them. We should invite the Soviet Union to join a U. N. committee which would immediately set a maximum dosage of permissible fallout from testing well below the level brought about by recent tests. The U. N. committee should then assign a quota to the United States and its allies and another to the Soviet bloc on a 50–50 basis. (Since most of the potential "fourth" powers are in the West, this would be a considerable concession to the U. S. S. R.) For 2 years all powers would agree to register with the U. N. all tests which involve fallout and both sides would agree not to exceed their quota. During those 2 years the quota would be progressively reduced, ultimately to zero. Afterward, unless there were by then a general disarmament agreement, nations would remain free to conduct surface tests of "clean" weapons, underground tests, and tests in outer space, so long as they did not cause fallout. Technical experts from both sides would agree on an adequate inspection mechanism, which could be relatively simple.

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[10] For a fuller discussion of the problems of the defense of Europe see the author's Missiles and the Western Alliance, Foreign Affairs, April 1958.

While such an agreement would impede the arms race, it would not stop weapons development altogether. It would permit the continued elaboration of defensive weapons and of weapons which can be applied with discrimination, both in terms of fallout and in terms of yield. Indeed it will put a premium on such development because these weapons can be tested most easily underground or within established fallout quotas. It will avoid placing the United States in the position of not trusting its allies with the development of weapons which are essential to their defense and which their opponent already possesses in quantity. At the same time, it will impede the too rapid diffusion of nuclear technology and thereby afford time for a careful study of this problem.

OUR NEED FOR NUCLEAR WEAPONS—QUALITY AND QUANTITY

By Lewis L. Strauss [11]

Both as a citizen and as a Govermnment official, I am aware that scientific advances in weaponry have increased, and are increasing, the ability of an aggressor nation to launch an attack which could be extremely damaging to the United States. Because we are a democracy, we are cast in the role of defenders and cede to totalitarian governments the role of aggressors. There is an enormous distinction in this statement of simple fact. The targets of the attacker are large, that is, our cities. The targets of the defenders are small, that is, enemy planes and missiles. Our weapons of the defender therefore need to be much more sophisticated in design than those of the aggressor. They must be both more accurate and more numerous than the weapons of the aggressor and, since many would be used over our own or friendly territory, they must be designed to perform their function and to produce the absolute minimum of radioactive debris.

* * * The military forces of the free world, spread over long exterior lines, cannot defend themselves without the aid of nuclear weapons against a possible Communist aggressor who can move rapidly and concentrate at any point on the periphery. * * *

Yet, we are now, as you know, in a transition period insofar as nuclear weapon design is concerned. * * * New systems, to be truly effective, must be light, rugged, and instantly ready. If all types of aggression are to be avoided or countered, the systems and their warheads must be capable of use in all locales and in all environments.

We have made substantial strides in developing the weapons systems we need. Yet with regard to some, particularly those of extremely severe design characteristics, we still need further development and test. This is particularly true with regard to weapons of greatly reduced radioactive fallout. In the interest of civil populations, we are convinced that such weapons are a necessity in all types for both strategic and tactical use. We know now how to make certain of the

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[11] From testimony before the Senate Committee on Foreign Relations Subcommittee on Disarmament. Hearings, pt. 17, April 16 and 17, 1958, Washington, D. C. Washington, U. S. Government Printing Office, 1958, pp. 1550–1604. Mr. Strauss was at that time Chairman of the United States Atomic Energy Commission.

designs we need, but by no means all. As I have indicated, it will require more development and more tests before we will have this comprehensive arsenal.

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The real danger to the human race is not the continuance of weapons tests. The real danger to the human race is a nuclear war.

Our weapons tests to perfect our stockpile of nuclear weapons has as its purpose the deterrence of a nuclear war. Over the period of centuries the developments of new weapons have preceded by a considerable number of years the development of countermeasures to those weapons. The weapons have, when they first appeared, seemed to be invincible. I won't burden you with citations from history with which you are undoubtedly more familiar than I am—the use of the long bow at Crecy against armed knights is a case in point.

The development of the atomic weapon was assumed and announced and believed to be the ultimate weapon, with no defense against it. We are now in the period of developing defense.

Since we are a defendant nation and cast in that role by the fact that we are a democracy and are not aggressors, it would be a tragic mistake, in my opinion, to cease the development of our defenses unless the whole threat of a surprise attack with atomic weapons were canceled at the same time.

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ADEQUACY OF NUCLEAR STOCKPILE

Senator HUMPHREY. Do you believe that our present atomic-thermonuclear weapons stockpile is superior to that of the Soviet Union in quantity, in quality, design, and variety?

Mr. STRAUSS. The answer to that question, Mr. Chairman, is based to a very considerable extent upon the interpretations from intelligence data.

It is my belief, which I cannot substantiate, but having been in the business of manufacturing weapons for a period of some years, longer than the Soviets, that we have more weapons. It is my belief that we have more efficient weapons.

But it would be a great mistake to assume that if those two points that I have made are accurate and true, that the weapons which they have, which we know they have, would not be sufficient with the proper delivery systems available to mount a very devastating attack.

Senator HUMPHREY. But it would be presumed, would it not, Admiral, that if such a devastating attack were mounted as an aggressive act, our stockpile would not be locked up, but we would retaliate?

Mr. STRAUSS. That is the announced policy of the Government.

Senator HUMPHREY. Therefore the deterrent effect upon which we have relied, at least in part, as a means of maintaining the peace, would still exist regardless of the cessation of tests, is that not true?

Mr. STRAUSS. That is true, but there are instances in history, and some in recent history, where the existence of an overwhelming force has not prevented military adventures that have been disastrous to the aggressors, and which in the light of history will seem to have been very imprudent and unreasonable adventures on the part of the aggressors.

We must be prepared to protect our people from the consequences of so ill-advised attack by an aggressor, if we can, by destroying his weapons before they impact on our cities.

FIRST STEP TOWARD PEACE: A TRIAL DISARMAMENT AGREEMENT

By Harold E. Stassen [12]

I believe that a trial agreement for 2 years between the United States and the Soviet Union on a first-step limitation of armaments and the suspension of nuclear explosions under a rigid reciprocal system of inspection can be negotiated within the next 6 to 9 months.

I am convinced that such a first step, calling for equal sacrifices by both sides and affecting both evenly, could pave the way for a longer and more lasting control and limitation of armaments while at the same time lessening the dangers of war.

Such a trial agreement cannot and must not be allowed to be a substitute for our continuing a powerful and alert military position. But it would give us time to seek and make further progress toward a more inclusive and lasting agreement.

Should the trial period end in failure, or if we are unable to convert it into a more substantial agreement, this 2-year agreement would not and could not constitute a handicap to our security or to our efforts to maintain the peace.

After a long study and first-hand dealing with the major problems affecting peace, I propose that the first step or trial agreement consist of four basic parts:

First, the establishment of a special agency of the United Nations with the responsibility of inspecting and assuring the fulfillment of the steps agreed upon by signatories for the reduction, control, and limitation of armaments.

Second, the installation of necessary inspection posts inside the territories of the Soviet Union and the United States, equipped with scientific instruments designed to verify the ending of nuclear test explosions.

Third, the Soviet Union and the United States to agree not to conduct any nuclear explosions for 2 years from the date the treaty is ratified both by the United States Senate and the Supreme Soviet.

Fourth, the setting up of a negotiating group to work effectively and seek diligently additional steps of disarmament during this first 2-year period.

STEPS TERMED FEASIBLE

In my opinion these four measures of a first step are feasible. On the basis of the progress made in the thorough and persistent negotiations in London in 1957, I believe that such a first-step agreement could be worked out during 1958.

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We must expect that such an agreement would put some brakes on research and further development and advance in nuclear weapons by the United States.

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[12] From Stassen Hopeful on Arms Accord. New York Times, February 26, 1958, pp. 1, 5. Mr. Stassen published this article shortly after he resigned as special assistant to President Eisenhower on disarmament matters.

But it would likewise put some brakes on further advances in nuclear weapons by the Soviet Union.

In this period of 2 years, more time would also be provided for scientists to follow through in their research on the effects of radiation from strontium 90 and cesium 137, thrown into the atmosphere from the nuclear tests.

Research thus far seems to make it quite clear that this radiation is not grounds for the kind of alarm that some have expressed. But it also seems clear that this radiation is not entirely harmless, and that the degree of harm has not yet been adequately measured by essential and thorough research.

The trial period and first-step agreement I propose would have the effect of opening up both sides to a beginning of necessary United Nations inspection, and would develop experiences in the methods of limitation and control. It would put the United Nations realistically and practicably in the field of armament control * * *.

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It is fair to ask whether this trial period would necessarily bring about an even more substantial agreement in the limitation of armaments in the immediate future.

It is my view that the prospects for the future would be far better than if the present deadlock continues, giving rise to increasing tensions and a terrific arms race.

I believe that this first step of a 2-year trial agreement between the United States and the Soviet Union with the guaranty of rigid inspection would improve prospects of a lasting peace. It would be and should be acclaimed by millions of people around the world.

LIMITING THE DANGERS OF NUCLEAR FALLOUT

By Clifford P. Case[13]

* * * the Soviet Union, having completed a long series of tests of nuclear weapons—tests which have been described as putting into the atmosphere more radio-active material than ever before—announced to the world that she was unilaterally suspending further nuclear tests. She has challenged us to do likewise and reserves the right to resume testing if we do not follow suit.

What should we do, in the light of simple morality, of the safety of our population and of our security as a nation and the security of the free world?

These questions are not newly posed by the Soviet challenge. They have been with us for some time. The Soviet announcement of her suspension of testing merely brings them into sharper focus. It is crucially important that all of us attempt to understand and try to find the right answers, or if there are no truly right answers in view of the cruel dilemmas with which we are confronted, the best answers which are possible in the circumstances.

At the outset we must face and accept certain stark realities.

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[13] From remarks made by Senator Case, of New Jersey, at a luncheon held by the Advertising Club of New Jersey. Reprinted in Congressional Record, vol. 104, April 15, 1958, pp. 5767–5768.

First, the Soviet Union is determined to bring the whole world within the Communist orbit. If it were not for the power of the United States she could and would do this in short order. She will stop at nothing to eliminate the obstacle which we represent.

Second, our defense, and the defense of the whole free world, against Soviet aggression is based upon, and depends upon, atomic and hydrogen weapons.

Our capacity to wreak unbearable destruction upon the Soviet Union by using such weapons is the only deterrent against her use of such weapons against us.

But this is by no means the whole story. Nuclear weapons are not only deterrents against an all-out thermonuclear attack upon our homeland; increasingly such weapons are becoming our essential reliance in containing Communist aggression of all degrees and in all parts of the world. Whether such aggression be based upon the use of nuclear weapons or merely conventional forces, to an important degree right now, and increasingly for the future, unless the present trend is sharply reversed, we are and will be dependent upon nuclear weapons to fight little as well as big, limited as well as unlimited, wars.

I realize there is a highly respectable body of opinion which believes it is impossible to limit a war in which any nuclear weapons whatever, however small, are used. Those who hold this opinion believe that inevitably the nation against whose forces small nuclear weapons are used will respond with the use of large nuclear weapons, evoking a counter response with even larger nuclear weapons, and this process will continue until the whole world is ablaze.

There is force in this argument. If it is correct, our present policies are dangerous in the highest degree and hideously wrong. Are we basing our defense on weapons which we will dare not use unless our very existence is directly threatened? If so, the whole free world will be defenseless against any aggression short of a thermonuclear attack upon the United States. Surely, this is a matter which ought to be the immediate and vital concern of every American, indeed of every human being. No single man or government should decide this question. Above all, it should be decided by conscious decision, not by the mere play of events.

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Today we do rely, we do depend, on nuclear weapons to defend ourselves and the free world against less than all-out aggression, as well as to deter the use against us of the hydrogen bomb. Since we do rely on such weapons for that purpose, we must have them in all sizes and adapted to all purposes. Both the safety of our own troops and that of the civilian population in the areas in which nuclear weapons would have to be used demand that we make every effort to reduce to a minimum their contaminating effects. For the safety of our own population we must do the same with nuclear weapons which are used in our defenses against nuclear or even nonnuclear intermediate range and intercontinental ballistic missiles.

If the responsible officials of our Government tell us that further testing is required to solve the technical problems involved in the development and maintenance of effective weapons for these purposes, this is a conclusion which I believe we must accept.

Assuming that continued nuclear tests of some kinds are necessary, can they not be so conducted as to limit the danger of widespread contamination from nuclear fallout? This is the crucial question.

If it is possible to do this, it should, it must, be done—for two reasons. First, a decent concern for humanity in our own day, and, even more, of generations yet unborn, compels it. Second, we must not let our enemies succeed in using the fear of poisoning the atmosphere—a fear felt increasingly by millions both in America and abroad—to halt our testing and development of weapons which may be essential to our very survival and to the protection of freedom everywhere on earth.

It is said that we, at least, have made great strides in the development of clean weapons of large size. Also, it has been intimated that, for the purposes of our defense, we have gone about as far as we need to go in the testing of weapons of enormous size and that the real need is for the perfection of a variety of smaller weapons, the testing of which can be conducted with relatively little radioactive fallout.

If this is so, I believe we should at the earliest possible date announce it is our national policy that we will conduct no tests of nuclear weapons that will cause a dangerous contamination of the earth's atmosphere. We should couple our announcement with an offer to have our tests monitored by a competent impartial international agency to guarantee that the announced limitations are observed.

At the same time we should initiate steps to secure an international agreement among all nations now or hereafter conducting nuclear experiments looking toward an overall limitation, subject to similar surveillance, of all nuclear testing so as to prevent further contamination of the earth's atmosphere.

If this course is feasible and consistent with the requirements of our security, we ought to make such an announcement at once. If it is not, we and all the world ought to know that, too, and the reasons why. The people of this country and of the world will accept such reasons if they are valid.

ADVANTAGE OF A TEST CESSATION AGREEMENT

By Hans Bethe [14]

Senator HUMPHREY. Doctor, do you feel that our design, variety, and stockpile of weapons is superior to the Soviet Union today?

Dr. BETHE. I certainly do, but the Soviet Union has a satisfactory system. [Deleted.]

Senator HUMPHREY. Then if it were possible—and I qualify that with a big "if" in light of the testimony we have had in the last couple of days—if it were possible to get an agreement which would provide access of inspection teams to doubtful areas, I mean areas where the monitoring stations indicated tests might have occurred, would it be

[14] From testimony before the Senate Committee on Foreign Relations Subcommittee on Disarmament. Hearings, pt. 17, April 16 and 17, 1958, Washington, D. C. Washington, U. S. Government Printing Office, 1958, pp. 1526–1547. Dr. Bethe is professor of physics at Cornell University and a member of President Eisenhower's Science Advisory Committee.

to our advantage or their [the Russians'] advantage in your mind to have such an agreement?

Dr. BETHE. To our advantage, in my mind.

Senator HUMPHREY. Very much to ours, or only modestly?

Dr. BETHE. Considerably to our advantage. I feel that if testing continues, then they will surely attain the same level of capability as we, and I feel that it is just a matter of simple logic that for the relative standing it is more advantageous to stop when you know that you are still ahead.

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Senator SYMINGTON. And inasmuch as you have analyzed it probably as much as any man around, how do you feel, what do you think we should do now, in your personal opinion?

Do you feel we should enter into a cessation of test agreements with these people [the Russians]?

Dr. BETHE. That is my opinion, provided they agreed to a good inspection system with all the trimmings that I have outlined, and I should like to add that the inspection system in itself would be of value, because it would to some extent open up Russia and help to reduce tension between the two countries.

Senator SYMINGTON. Do you think there is any necessity for that test suspension to be tied up with the question of the cessation of production?

Dr. BETHE. No.

Senator SYMINGTON. Thank you, Mr. Chairman.

POLITICAL DESIRABILITY OF INSPECTION SYSTEM

Senator HUMPHREY. I have tried to make the same point that you have just raised, Dr. Bethe, that getting the inspection system on its own, regardless of the testing, would be a political advantage.

Dr. BETHE. Yes.

Senator HUMPHREY. It would be politically desirable.

Dr. BETHE. Yes.

Senator HUMPHREY. I have also felt that when the Soviet spokesmen have mentioned that they were prepared to negotiate an international inspection system it has been my feeling that we should probe them to find out just what they mean. I am quite convinced in my own mind that they are going to do a lot of foot-dragging, that it is going to be very difficult. But we will never find out what they are talking about, and will never really be able to give them the political litmus paper test until we try it. They keep talking about international inspection, but the last experience we had on that was Korea, and that was anything but a heartening one.

I am of the opinion that we ought to be pushing them and find out what they really mean, and in the meantime try to get international teams under the U. N. working on all of this detection apparatus system as much as we can. That has been my personal view about it.

Dr. BETHE. Yes.

Senator HUMPHREY. Do you agree with that?

Dr. BETHE. I entirely agree. I should like to add about the inspection system that apparently there are a lot of seismic stations already in Russia. If they were to admit international inspectors to the existing stations, this might be a start.

Senator HUMPHREY. It would be possible, would it not, also to consider negotiating an agreement along the lines that some others have talked about, I mean with certain limitations involved, on weapons size or on radioactive yield.

Dr. Libby talked to me about one proposal he had.

Dr. BETHE. Yes. There is one point, however, which I consider very dangerous. It has been proposed to test only underground, to permit mainly underground tests. I have heard that proposal from many sides. This I consider not a solution of our main problem because our main problem is to stop their development.

BOMB TESTS AND THE ARMS RACE

By the Friends Committee on Legislation [15]

DO ARMAMENTS "PREVENT WAR"?

History provides no proof that armaments prevent war.

Reliance on nuclear weapons is increasing. The United States has now switched seven divisions to primary reliance on tactical, "small" atomic weapons and is converting other divisions presumably at an accelerating rate. There is no doubt that the Soviet Union is doing the same.

We should question this reliance on nuclear weapons to prevent war. Today, events sliding out of control are more likely to be the cause of a general war than is a planned attack. Nuclear war might not be started deliberately, but might grow from a "brush fire" war in which one side resorts to nuclear weapons. The assumption that nations actually fear to use these weapons because of the devastating effects on their own country may also prompt diplomatic gambling followed by attempts to "call the bluff" until some power is goaded into acting—and starting a war.

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The simple truth is that, even granted a temporary stalemate, there is no permanent peace in an arms race, nuclear or otherwise.

WHAT WOULD BE THE DESTRUCTION FROM A NUCLEAR WAR?

Here we find almost unanimous agreement among scientific, military, and political spokesmen.

Major General Gavin

One hundred and ten superbombs dropped on the United States would kill or maim 70 million persons and several hundred million more would die from the radioactive fallout, somewhere in the world, depending on which way the wind blew.[16]

AEC Commissioner Libby

Radioactive fallout from a nuclear superbomb could blanket an area as big as 100,000 square miles under windy conditions * * * and kill 85 percent of those living within 12 miles of target zero.[17]

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[15] From questions and answers about nuclear tests. San Francisco, Friends Committee on Legislation, 1957, pp. 10–12.

[16] Testimony before Senate Armed Services subcommittee, June 28, 1956, quoted in Washington Post editorial (July 6, 1956).

[17] United Press release, Washington Post (January 19, 1956).

Civil Defense meterologist Charles Schafer

If Russia hit 144 American population centers with 250 bombs, each with a power of 10 million tons of TNT (less than two-thirds the force of the bomb exploded on Bikini in 1954) 82 million American lives would be lost.[18]

President Eisenhower

There will be no such thing as a victorious side in any global war of the future.[19]

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WOULD "CLEANER" BOMBS CHANGE THE NATURE OF NUCLEAR WAR?

There is much talk about "limited war" employing "tactical," "small," and "clean" nuclear weapons. History gives little indication that military tacticians ever use weapons of less than full destructive capacity in the fury of warfare. The United States did not hesitate to use the then awesome atomic bomb in the 1945 invasion of Japan.

Peacetime testing and wartime use of nuclear weapons are two distinctly different things. The waging of warfare is basically an irrational act. It is brought about by the failure of men to arrive at rational agreement. And when agreement on arms limitation fails during peacetime, it is even more logical to conclude that there will be no limitation on the use of arms during wartime.

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Also, the clean bomb * * * increases the probability that nuclear weapons will be used in a future war. It contains less fallout; therefore, it is less likely to harm the aggressor as well as the victim. Thus, this kind of bomb becomes less unthinkable to a desperate nation. By this very fact it makes disarmament all the more imperative. For to a small degree that deterrent of "mutual terror" is lessened by the "clean" bomb.

War was never "clean."

WHAT HAPPENS WHEN THE BALLISTIC MISSILE CARRYING A HYDROGEN BOMB IS PERFECTED?

The H-bomb is now being married to the intercontinental ballistic missile (ICBM) which could streak through the air at speeds up to 16,000 miles an hour and at heights up to 600 miles. It would be able to span oceans and plummet down continents away to grind large cities to dust.

Military experts argue that further nuclear testing is necessary at least for the rapid wedding of ICBM's and hydrogen warheads; we must keep ahead of the economy in weapons development.

To arguments of this type, the London Times comments:

If agreement has to wait on the last invention, there will be no agreement. Someone is always on the brink of discovering something.[20]

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[18] News dispatch in San Francisco Chronicle (May 28, 1957), p. 1.
[19] James Reston, San Francisco Chronicle (June 27, 1957).
[20] London Times editorial (July 3, 1957).

And if we permit its development which may be just around the corner, another terror point lies just beyond when a 5th or 6th or 10th nation has the bomb and the missile. If this point is reached, what then? If all nations are testing, and the ground is honeycombed with hidden rocket-launching sites which cannot be certainly detected, it may then be impossible for all the good faith in the world on the part of 99 percent of humanity to gain assurance that 1 percent is not prepared to bring the whole world down about our heads.

II. CONTROL AND INSPECTION

ELIMINATING NUCLEAR WEAPONS

By United States Department of State [1]

For 9 years the major preoccupation of disarmament negotiators in the United Nations was the conclusion of an agreement to eliminate nuclear weapons. But with the passage of time nuclear weapon stockpiles expanded greatly and production technology changed significantly. The studies in 1955 thus indicated that neither our scientists nor the scientists of other countries were able by this time to devise methods which could account completely for all past production of nuclear materials, and the margin of error in known detection methods was beyond the limits we could contemplate for an acceptable inspection system. Nor was it possible to remedy this by attempting to search out any "clandestine" weapons. Scientific advances made it possible to concentrate great destructive force in a single bomb. Properly insulated the nuclear material within the bomb defied detection by the most sensitive instruments at distances only a few yards away. Even small diversions of nuclear materials would be sufficient to give an aggressor decisive strength in launching a great attack if the other side had fulfilled its obligation to destroy all such weapons.

We had reached the point of no return in eliminating nuclear weapons—at least until more adequate scientific detection methods were devised. In the absence of more reliable detection methods, elimination of these weapons could be accomplished only if universal good faith was linked irrevocably to the execution of an arms agreement. But with the existing degree of international tension and hostility, no nation was prepared to gamble its national security on unverifiable commitments.

Thus we faced the inexorable conclusion that security in the nuclear age could not depend on unverifiable assurances that the bomb would be eliminated. Freedom from fear would have to be sought in steps to control the bomb rather than in unenforceable agreements to eliminate it.

CAN WE DISARM?

By Richard A. Preston [2]

THE FUNDAMENTALS OF THE QUESTION

Failure to make progress in negotiation goes much deeper than the attitudes developed by the negotiators. The root of the problem is twofold. In the first place the great ideological and power struggle

[1] From Disarmament, the Intensified Effort, 1955–58. Washington, U. S. Government Printing Office, 1958, p. 10.

[2] From Can We Disarm? Toronto, Canadian Institute of International Affairs, 1958, pp. 15–16. Mr. Preston is professor of history in the Royal Military College of Canada.

between East and West, and particularly between the United States and Russia, brooks no compromise when each side is waiting for the collapse and destruction of the other's system and suspects that the other will try to forestall this collapse by aggressive war. Secondly, the present system of independent states, upon which each side relies in the power struggle, permits no serious infringement of its basic principle, the sovereignty of nations. An effective system of international inspection to control all armaments would mean the creation of a superauthority of a kind which the nations are apparently not yet prepared to accept. The Russians, who have shown themselves to be the more inclined to an aggressive policy, if only by subversion and the stimulation of internal upheaval in the West, are hardly likely to accept an international control which would limit their ability to pursue an independent national policy.

At the same time there is no reason to believe that the West would be any more sympathetic to a serious reduction of national sovereignty. When even the semblance of a loss of sovereignty and control by 1 of 2 close allies like Canada and the United States raises an immediate nationalist outcry, how much more difficult must be the arrangement of a diminution of sovereignty between enemies. Furthermore, it is not even certain that western negotiators could carry into effect any treaty which they agreed upon in the disarmament commission. Would the United States Senate ratify a treaty which made serious infringement upon American sovereignty? Would Congress vote funds for the American share of an international inspection scheme which brought Communists into and over the United States? The answer to these questions cannot be an unqualified "Yes."

The conclusion which would appear to follow is that a full disarmament program is unlikely in the foreseeable future. This leaves us with the possibility of partial disarmament. Such a program would not remove the threat of a total nuclear war. It might have the valuable effect of contributing to the easing of international tension. But history suggests that no kind of disarmament can be negotiated to ease tension and that to attempt it for that purpose is putting the cart before the horse. Nevertheless a partial program might be attractive to the powers as a means of reducing the crushing burden of armaments. It might appeal to governments as being a concession to the worldwide demand for disarmament without the surrender of the national security burden which responsible governments bear. Lastly, no one can foresee what will be the effect on statesmen of the growing belief that war is no longer a feasible policy. There are those who, in consequence of this belief, argue on the basis of inaccurate historical analogies that "limited war" is now still a possibility. It may be more likely that a "limited" disarmament agreement may now be negotiable which, if war is avoided for an appreciablet time, will one day give place to full disarmament. The alternative is an increasingly competitive nuclear-arms race; and history shows that arms races usually end in war.

THE "NTH" COUNTRY PROBLEM

By the National Planning Association [3]

The problem of achieving international arms control will become vastly more difficult when the three powers now having nuclear weapons are joined by a fourth, and then a fifth, and possibly more. This prospect is often referred to as the "fourth" country problem; in France it is always called the "fifth" country problem. We prefer to think a more realistic term is the "Nth" country problem.

There is almost universal understanding of the techniques and the "secrets" involved in atomic weapons. The false confidence in "secrets" which existed in 1945 is now dissipated. It will be recalled that some reputable scientists then predicted it would take the Soviets 20 years to duplicate the work performed in the United States. But others—like Dr. Reuben G. Gustavson, then vice president of the University of Chicago, who pointed out that the principles involved in the bomb were discussed in the Russian journal of chemistry just before the war—predicted that Russia would have the bomb shortly, and these predictions were confirmed in 1949.

Breakthroughs, refinements, shortcuts in manufacture, and reductions in cost are not unique to any one country. The United States, the Soviet Union, and Great Britain achieved nuclear and thermonuclear weapons capability essentially without outside assistance.

There are at least four ways in which a power can attain atomic capability:

It can develop a bomb with its own resources and with no outside aid. The task is not beyond the capacity of highly developed nations with substantial scientific resources and with one or more nuclear-power reactors. It has been estimated that France will produce several dozen Nagasaki-type bombs within a few years. In the October 1957 Foreign Affairs, Prof. Klaus Knorr says:

> It can also be taken for granted that, without going outside their own resources, Canada, Sweden, Belgium, Eastern Germany, and Czechoslovakia could begin production of nominal bombs within 5 to 7 years; and Communist China, Japan, India, Switzerland, Italy, and Western Germany probably have similar possibilities.

A country may receive a reactor as part of a bilateral or multilateral assistance program and use it to breed material. But it also could surreptitiously divert such material as is furnished to the production of atomic bombs. Prof. Otto Hahn of Germany, who won a Nobel prize for having discovered fission of the uranium atom, said:

> If the smaller countries and the underdeveloped countries receive atomic reactors, they will also be able to make atomic bombs. A reactor that produces electricity also makes plutonium, the stuff of atomic bombs.

There is the probability of direct military assistance to friendly nations in techniques and in stockpiling. Nations providing bases are tending to demand independent access to weapons.

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[3] From 1970 Without Arms Control; Implications of Modern Weapons Technology, by NPA Special Project Committee on Security Through Arms Control. Washington, 1958, pp. 39–42.

Nuclear bombs may be sold on the world market, as are many other weapons. There is already considerable trade in reactors for peaceful uses of the atom.

The rate at which we can expect the spread of nuclear capability to additional nations will depend upon each nation's present technology, its present industrial capacity, its level of education, and the rate at which these factors are changing. In the less developed economies, technological changes are considerably slower than in the industrial nations, even assuming the most favorable economic and social conditions. The capacity of basic industry, such as steel, can be doubled every 5 to 10 years, but many doubling times are required before less developed countries can possess the capacity to manufacture modern weapons on a large scale. For example, it would take India a considerably longer period of time than Japan to develop the capability of waging nuclear war because she is just starting along the path of industrialization. Nevertheless, it is not unlikely that India's capacity to wage war could one day exceed Japan's.

There are several factors which intensify the desire of nations to join the atomic club. Not the least of these is the desire for national prestige. Furthermore, British leaders say that the most effective military use for limited economic resources is in the production of nuclear weapons and a reduction of conventional forces and this argument from the point of view of economy may gain adherents in other countries.

Another impetus toward independent nuclear capability is the fear that reliance upon friendly powers for nuclear intervention will, in a showdown, cause disappointment. Who can say with complete assurance that one nation would fire nuclear weapons in another's defense, when to do so might provoke nuclear retaliation against itself? There is some fear that today's intentions, rulers, policies, and attitudes might change tomorrow. Nations may be reluctant to rely on the hope that allies will at all times be ready to risk almost certain atomic retaliation in their behalf. Each year will produce new drives impelling nations to seek nuclear weapon capabilities, and each year will produce new opportunities for their acquisition.

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A distinction must be drawn, of course, between a full arsenal of atomic and thermonuclear weapons and a small supply of nominal atomic bombs. The creation of a complex delivery system to deliver these bombs on distant targets involves huge resources in materials, sicentific manpower, machinery, and funds. But through military assistance programs, the forces of many small nations have been trained in the operation of the most modern aircraft, and a considerable amount of aircraft has been distributed under such programs. Sweden, Switzerland, France, and Great Britain have independently developed effective missiles in the shorter range categories. A Swiss company now sells guided missiles to other governments. At the NATO summit meeting in December 1957, it was agreed in principle that ballistic missile bases would be constructed in west European countries.

However, the possession of a small number of weapons, compact in size and capable of destroying whole ports, airfields, manufacturing plants, or cities, would place tremendous power in the hands of a small nation. Under irresponsible control, they could be used for blackmail.

They could also catalyze wars which inevitably would involve larger powers.

* * * it is expected that a rapid rise in the number of atomic powers can be expected by the mid-1960's. By 1970, most nations with appreciable military strength will have in their arsenals nuclear weapons—strategic, tactical, or both. This illustrates a general tendency; any new weapons capability would probably spread in like manner.

THE DETECTION OF NUCLEAR TESTS

By Edward Teller [4]

For years there has been diligent and excellent work on the question how to detect tests. We were vitally interested in tests going on everywhere, and so the methods of detection have been developed.

Except for a little work in the last few months, there has not been work on the question how to hide tests. Therefore, our knowledge of hiding tests is deficient. Even so, even matching this deficient knowledge against a well worked out system of detection, we already see strong possibilities, effective possibilities of hiding tests * * *.

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There is agreement on this. Small tests, tests of small explosions, can be hidden. Tests of big explosions can not, as we stand today.

This may change in the course of time.

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First of all, these small tests are important in themselves because the weapons they test can perform exceedingly important roles in many military situations. * * *

Second, by making small tests, one can learn a very great deal about big explosions. With the help of small tests, one can improve one's big weapons.

This does not mean that big tests are unnecessary. But it does mean that if there is a test cessation, and one party uses the possibility of testing small explosions in secret, and the other party does not, then the violator will have gained a great advantage not only in the field of small weapons but in the field of the big weapons as well.

Thirdly, by testing small explosions, one is learning more and more about the way how bigger explosions can be hidden.

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UNDERGROUND TESTS: A METHOD OF HIDING

To hide small explosions does not mean to perform them in such a way that nobody can notice them, at least not necessarily so. There is particularly one method of hiding which has been quite generally discussed, and that is to hide a test by putting it underground. No radioactivity whatsoever escapes. But there is an earthquake signal.

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[4] From testimony before Senate Committee on Foreign Relations Subcommittee on Disarmament. Hearings, pt. 17, April 16 and 17, 1958, Washington, D. C. Washington, U. S. Government Printing Office, 1958, pp. 1455–1494. Dr. Teller is director of the University of California Radiation Laboratory, Livermore, Calif.

Now the crust of our earth is an exceedingly noisy place. There are many thousands of earthquakes throughout the surface of the globe each year with which a small nuclear explosion can be confused. The question is how to make the signal from a nuclear explosion small enough and, if possible, how to make it similar enough, to a signal from an earthquake.

Now, this is a highly technical subject, but the main thing about it is that it is a subject about which our knowledge is very poor. What an earthquake is, what is the cause, what is the starting point of an earthquake, slipping of layers, or whatever, is not known in detail. What a nuclear explosion underground will do, we know from 1 and only 1 shot, and a smaller shot at that.

DANGER OF COMPARING FACTS ABOUT EARTHQUAKES WITH INFORMATION FROM A SINGLE NUCLEAR EXPLOSION

If we had not performed this one shot, we would compare the known facts about earthquakes with a complete vacuum of knowledge.

Now, we are extrapolating from a single event which we know well. This is an extremely dangerous situation.

We need lots more information upon this subject. If we go into a test moratorium, with deficient knowledge, and if thereupon we do not continue to test, but the Russians experiment with small nuclear explosions which we know can be hidden, then by their experimentation, they may find out a great deal. I think they will find out more and more and clearer and clearer methods how to make these explosions disappear among the many earthquakes which occur spontaneously. A great deal can be done by hiding tests in this manner, because it is a scientific question that as yet has been hardly attacked at all.

OTHER POSSIBLE METHODS OF HIDING TESTS

Now there are many other methods how to try and hide tests. And it would be a mistake to think underground tests are the only means of evasion. It is wrong to think that a net of seismic stations in the Soviet Union will make us safe. There are all kinds of other ways how a test moratorium could be circumvented.

I would not like to go into this question because the subject is infinite. I should just like to assure you that the thinking along these lines has just started.

RELIABILITY OF AN INSPECTION SYSTEM

I would like to say that there is, in my opinion, one reliable way how to check a test moratorium, and that is the human way.

If our people could get into Russia in any numbers, if they could go to any place, if they could talk to anybody, if also we would be sure that Russians, Russian scientists who repeatedly talk with our people will not suffer because they have talked, then I think we could learn about tests. We could find out from the many people who are involved in a nuclear test.

This would mean an opening up of Russia, and this in itself would really be a wonderful thing. About that possibility, I would only say that if it is a real one, I am all for exploring it. But the country must be really open and we should realize that our own country is

absolutely open, and that even if Russia should open up to the greatest extent we can now imagine, we still would have our own wonderful institutions of which we are justly proud, like the institution of a free press, which will make it for us forever impossible to do anything but abide most strictly by any agreement which we have undertaken.

Russia will have to open up a very great deal to begin to match that.

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CUT-OFF OF PRODUCTION OF FISSIONABLE MATERIAL FOR WEAPONS PURPOSES

Now, I should like to come to the next question which has been raised in the opening statement of the chairman, the question of limiting and checking production.

I should like to say about that quite briefly that I believe that to limit production and check this limitation is as difficult, and it may be more difficult, than to check tests.

I should say that this, too, will require essentially an openness of the country and an openness of access, which is very, very foreign to the present practices in Soviet Russia.

INSPECTION OF STOCKPILES

Finally, I would like to discuss the checking of stockpiles, to the idea that the stockpiles in the long run might diminish and eventually vanish. To that I would like to say that this is the most difficult of all.

Stockpiles can be so easily hidden that I believe that this is really practically impossible.

EFFECTIVENESS OF NUCLEAR INSPECTION

By Hans Bethe [8]

UNDERGROUND TESTS TO DETERMINE SEISMIC SIGNALS

Now Dr. Teller and a number of other people who are very strongly against test cessation will argue that a country which is insistent on violation of the test agreement can defeat the inspection system by conducting underground tests in surroundings where you get a very small seismic signal.

My personal opinion is that this will be true only to a very limited extent, and if a country is intent on defeating a test cessation agreement and violating it, then it will have to conduct a lot of experiments underground with low-yield weapons to find out whether seismic signals from these are detectable.

It is my opinion that this would be a very dangerous game for them to play and that somewhere on creeping up on the yield they would be detected.

It is Dr. Teller's opinion that they might get away with it, and this is simply a difference of opinion. Neither of us, I think, has a very firm basis for it. I am convinced that somewhere there would be a

[8] From his testimony before Senate Committee on Foreign Relations Subcommittee on Disarmament, previously cited on p. 19.

slip and the inspection system would detect a test if such a series were conducted let's say by the Soviet Union.

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INSPECTION OF CURRENT NUCLEAR PRODUCTION AND STOCKPILES

As far as the inspection of production is concerned * * * I entirely agree with Dr. Teller that it would be extremely difficult to ascertain that material from weapons stockpile is returned to peaceful purposes.

On this I see no way, no good way of doing it. But making sure that current production is not diverted to weapons I think is not a difficult task because you can find the plants even though they are not advertised, and you can certainly, once you are in the plants, you can certainly find out where the material goes. For current production I think there is not much difficulty. For past production, I think it is impossible, or nearly impossible.

REPORT OF THE GENEVA CONFERENCE ON THE DETECTION OF NUCLEAR TESTS[6]

CONCLUSIONS ON A CONTROL SYSTEM FOR DETECTING VIOLATIONS OF A POSSIBLE AGREEMENT ON THE SUSPENSION OF NUCLEAR TESTS

The Conference of Experts, having considered a control system for detecting violations of a possible agreement on the suspension of nuclear tests, has come to the conclusion that the methods for detecting nuclear explosions available at the present time, viz, the method of collecting samples of radioactive debris, the methods of recording seismic, acoustic, and hydroacoustic waves, and the radio-signal method, along with the use of onsite inspection of unidentified events which could be suspected of being nuclear explosions, make it possible to detect and identify nuclear explosions, including low-yield explosions (1–5 kilotons). The Conference has therefore come to the conclusion that it is technically feasible to establish, with the capabilities and limitations indicated below, a workable and effective control system to detect violations of an agreement on the worldwide suspension of nuclear weapons tests.

The Conference of Experts has come to the following conclusions regarding such a system:

1. The control system should be under the direction of an international control organ which would insure the coordination of the activities of the control system * * *

2. A network of control posts is characterized by three main parameters:

(*a*) The minimum yield adopted for the nuclear explosion or the natural events giving equivalent signals;

(*b*) The number of control posts;

(*c*) The probability of correct identification of natural events, particularly earthquakes.

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[6] From report of the Conference of Experts To Study the Methods of Detecting Violations of a Possible Agreement on the Suspension of Nuclear Tests. United Nations Document EXP/NUC/28, August 20, 1958 (English), pp. 15–20.

The Conference considers that the problem of detecting and identifying underground explosions is one of the most difficult, and that, to a large extent, it determines the characteristics of the network of control posts.

3. The network of control posts would include from 160 to 170 land-based control posts * * * and about 10 ships. Of these 160–170 control posts about 100–110 would be situated in continents, 20 on large oceanic islands, and 40 on small oceanic islands; however, the exact number of control posts within the limits indicated above, can be determined only in the process of actually disposing them around the globe, taking into account the presence of noise at the sites at which they are located, and other circumstances.

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5. In addition to the basic network described, air sampling would be accomplished by aircraft carrying out regular flights along north-south routes over the oceans along the peripheries of the Atlantic and Pacific Oceans, and also over areas of the oceans which are remote from surface control posts * * *

6. When the control posts detect an event which cannot be identified by the international control organ and which could be suspected of being a nuclear explosion, the international control organ can send an inspection group to the site of this event in order to determine whether a nuclear explosion had taken place or not * * * The inspection group would forward a report on the investigation it had carried out to the international control organ, and to the government of the country on the territory of which the investigation was made in such a manner as may be considered appropriate by governments.

7. The network of control posts disposed as described, together with the use of aircraft as described, would have the following effectiveness * * *

(*a*) Good probability of detecting nuclear explosions of yields down to about 1 kiloton, taking place on the surface of the earth and up to 10-kilometer altitude, and good probability of detecting, but not always of identifying, explosions taking place at altitudes from 10 to 50 kilometers * * *

(*b*) Good probability of detecting nuclear explosions of 1 kiloton yield set off deep in the open ocean * * *

(*c*) Good probability of recording seismic signals from deep underground nuclear explosions in continents equivalent to 1 kiloton and above * * *

8. Along with the observation of signals of possible underground explosions the control posts would record at the same time a considerable number of similar signals from natural earthquakes. Although, with the present state of knowledge and technique, the network of control posts would be unable to distinguish the signals from underground explosions from those of some earthquakes, it could identify as being of natural origin about 90 percent of the continental earthquakes, whose signals are equivalent to 5 kilotons, and a small percentage of continental earthquakes equivalent to 1 kiloton. [23]

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[23] The Conference notes that in order to increase the percentage of earthquakes of less than 5 kiloton yield which could be identified, it would be appropriate to supplement the data from the control posts by trustworthy data from the best existing seismic stations. The results of the observations of these seismic stations should, for this purpose, be made available to the international control organ, and the equipment of the seismic stations suitable for this purpose could be improved by using the best modern apparatus.

It has been estimated on the basis of existing data that the number of earthquakes which would be undistinguishable on the basis of their seismic signals from deep underground nuclear explosions of about 5-kiloton yield could be in continental areas from 20 to 100 a year. These unidentified events which could be suspected of being nuclear explosions would be inspected as described in item 6.

The capability of the control system to identify underground nuclear explosions of 1- to 5-kiloton yield depends on—

(*a*) The small fraction of earthquakes that can be identified on the basis of data obtained from the control posts alone;

(*b*) The fraction of earthquakes that can be identified with the aid of supplementary data obtained from existing seismic stations; and

(*c*) The fraction of events still left unidentified which could be suspected of being nuclear explosions and for which the international control organ carries out inspection in accordance with item 6.

Although the control system would have great difficulty in obtaining positive identification of a carefully concealed deep underground nuclear explosion, there would always be a possibility of detection of such a violation by inspection.

The onsite inspection carried out by the international control organ in accordance with item 6 would be able to identify with good probability underwater nuclear explosions with a yield of 1 kiloton and above.

9. The Conference notes that in certain special cases the capability of detecting nuclear explosions would be reduced; for instance, when explosions are set off in those areas of the ocean where the number of control posts is small and the meteorological conditions are unfavorable; in the case of shallow underground explosions; when explosions are set off on islands in seismic regions; and in some other cases when the explosion is carefully concealed. In some cases it would be impossible to determine exactly the area in which a nuclear explosion that had been detected took place.

However, the Conference considers that whatever the precautionary measures adopted by a violator he could not be guaranteed against exposure, particularly if account is taken of the carrying out of inspection at the site of the suspected explosion.

10. The system described does not include specific means to detect and identify nuclear explosions at high altitudes (above 30–50 kilometers). * * *

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The Conference of Experts considers that it is possible to use the recording of ionospheric phenomena, using appropriate radio techniques, and of optical phenomena for the detection of nuclear explosions at high altitudes.

* * * The Conference of Experts has not considered the problem of the detection of nuclear explosions which might be conducted in cosmic space at distances of millions of kilometers from the earth.

III. BIOLOGICAL ASPECTS

REPORT OF THE UNITED NATIONS SCIENTIFIC COMMITTEE ON THE EFFECTS OF ATOMIC RADIATION[1]

GENERAL CONCLUSIONS

54. The exposure of mankind to ionizing radiation at present arises mainly from natural sources, from medical and industrial procedures, and from environmental contamination due to nuclear explosions. The industrial, research, and medical applications expose only part of the population while natural sources and environmental sources expose the whole population. The artificial sources to which man is exposed during his work in industry and in scientific research are of value in science and technology. Their use is controllable and exposures can be reduced by perfecting protection and safety techniques. All applications of X-rays and radioactive isotopes used in medicine for diagnostic purposes and for radiation therapy are for the benefit of mankind and can be controlled. Radioactive contamination of the environment resulting from explosions of nuclear weapons constitutes a growing increment to worldwide radiation levels. This involves new and largely unknown hazards to present and future populations; these hazards, by their very nature, are beyond the control of the exposed persons. The Committee concludes that all steps designed to minimize irradiation of human populations will act to the benefit of human health. Such steps include the avoidance of unnecessary exposure resulting from medical, industrial, and other procedures for peaceful uses on the one hand and the cessation of contamination of the environment by explosions of nuclear weapons on the other. The Committee is aware that considerations involving effective control of all these sources of radiation involve national and international decisions which lie outside the scope of its work * * *.

55. Certain general conclusions emerge clearly from the foregoing part of this report:

(*a*) Even the smallest amounts of radiation are liable to cause deleterious genetic, and perhaps also somatic, effects.

(*b*) Both natural radiation and radiation from fallout involve the whole world population to a greater or lesser extent, whereas only a fraction of the population receive medical or occupational exposure. However, the irradiation of any groups of people, before and during the reproductive age, will contribute genetic effects to whole populations insofar as the gonads are exposed.

(*c*) Because of the delay with which the somatic effects of radiation may appear, and with which its genetic effects may be

[1] From Report of the United Nations Scientific Committee on the Effects of Atomic Radiation. General Assembly Official Records, Thirteenth Session, Supplement No. 17 (A/3838), New York, 1958, pp. 41–42.

manifested, the full extent of the damage is not immediately apparent. It is, therefore, important to consider the speed with which levels of exposure could be altered by human action.

It is clear that medical and occupational exposure, and the testing of nuclear weapons, can be influenced by human action, and that natural radiation, and the fallout of radioactive material already injected into the stratosphere, cannot.

56. Present knowledge concerning long-term effects and their correlation with the amounts of radiation received does not permit us to evaluate with any precision the possible consequence to man of exposure to low radiation levels. Many effects of irradiation are delayed; often they cannot be distinguished from effects of other agents; many will only develop once a threshold dose has been exceeded; some may be cumulative and others not; and individuals in large populations, or particular groups such as children and foetuses may have special sensitivity.

* * * the possibility cannot be excluded that our present estimates exaggerate the hazards of chronic exposure to low levels of radiation. Only further intensive research can establish the true position.[2]

RADIOACTIVE FALLOUT AND ITS EFFECTS ON MAN

By the Joint Committee on Atomic Energy[3]

SUMMARY OF KEY POINTS

Some general observations may be made on the results of the hearings [of the Joint Committee on Atomic Energy on Radioactive Fallout and its Effects on Man.]

1. *Origin of fallout.*—It was pointed out that all nuclear explosions can be expected to produce some radioactive materials. However, certain kinds of explosions produce very much less radioactivity than others. Although there is no such thing as an absolutely "clean" weapon (that is, there is no such thing as a nuclear weapon detonation completely free of accompanying radioactivity), the amount of the radioactivity produced can be substantially altered in relation to the size of the explosion.

2. *Distribution of fallout.*—There was substantial, but far from complete, agreement on what happens to radioactive debris produced in man's environment, how much is there now, how and where it is distributed, and how much is in man himself. There was considerable evidence presented to indicate that in no part of the atmosphere is fallout uniformly distributed and that, therefore, the effects of fallout on the world's population could not necessarily be expected to be uniform.

3. *Biological effects of radiation.*—There was general agreement that any amount of radiation, no matter how small the dose, increases the rate of genetic mutation (change) in a population. There was, on the other hand, a difference of opinion as to whether a very small

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[2] The maximum permissible levels of exposure and maximum permissible body burdens of radioactive isotopes recommended in 1954–55 by the International Commission on Radiological Protection as applying in the case of occupational exposure must not be misinterpreted to apply in the case of exposure of whole populations.

[3] From its Summary-Analysis of Hearings, May 27–29 and June 3–7, 1957, on the Nature of Radioactive Fallout and Its Effects on Man, August 1957, pp. 2–3.

dose of radiation would produce, similarly, an increased incidence of such somatic (nongenetic) conditions as leukemia or bone cancer, or a decrease in life expectancy, in a population.

4. *Tolerance limits.*—There was general agreement that there is a limit to the amount of radioactivity and, hence, to the amount of fission products that man can tolerate in his environment. The extent to which existing and future generations will be affected by manmade radiation was shown to be intimately tied to certain decisions, moral as well as scientific, that must be made as to how much radiation can be tolerated by the peoples of the world.

5. *Effects of past tests.*—It was clearly shown that man's exposure to fallout radiation, including strontium 90, is and will be in general small, for the testing already done, compared with his exposure to other, "normal background" sources of radiation (a fraction of 1 to 10 percent), and even compared with variations in "normal background" sources. But it was not agreed on how this information should be interpreted.

6. *Effects of future tests.*—There were differences of opinion on how to forecast the consequences of further testing. The differences hardest to reconcile appear to be those concerning the biological effects of radiation. Pending a resolution of differences, it would appear from the information presented that the consequences of further testing over the next several generations at the level of testing of the past 5 years could constitute a hazard to the world's population. It is very difficult, if not impossible, to forecast with any real precision the number of people that would be affected.

7. *Effects of nuclear war.*—The catastrophic nature of the radiation effects from a multiweapon (atomic and hydrogen bombs) attack on the United States were clearly portrayed. This, of course, could be applied to any nation.

BIOLOGICAL EFFECTS OF RADIATION

By the National Academy of Sciences—National Research Council [4]

FALLOUT

There has been concern about the possible genetic harm due to the fallout of radioactive material which results from the testing of atomic weapons * * *.

From the point of view of this Committee there are two summary remarks that should be made. First, since any additional radiation is genetically undesirable the fallout dose is genetically undesirable.

Second, the fallout dose to date (and its continuing value if it is assumed that the weapons testing program will not be substantially increased) is a small one as compared with the background radiation, or as compared with the average exposure in the United States to medical X-rays.

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[4] From Report of the Committee on Genetic Effects. The Biological Effects of Atomic Radiation, summary reports from a study by the National Academy of Sciences. Washington, 1956, pp. 27, 29–30.

CONCLUDING COMMENTS

The basic fact is—and no competent persons doubt this—that radiations produce mutations and that mutations are in general harmful. It is difficult, at the present state of knowledge of genetics, to estimate just how much of what kind of harm will appear in each future generation after mutant genes are induced by radiations. Different geneticists prefer differing ways of describing this situation, but they all come out with the unanimous conclusion that the potential danger is great.

This report recommends that the general public of the United States be protected, by whatever controls may prove necessary, from receiving a total reproductive lifetime dose (conception to age 30) of more than 10 roentgens of manmade radiation to the reproductive cells. Of this reasonable (not harmless, mind you, but reasonable) quota of 10 roentgens over and beyond the inevitable background of radiation from natural causes, we are now using on the average some 3 or 4 roentgens for medical X-rays. This is roughly the same as the unavoidable dose received from background radiation * * *.

The 10 roentgens recommendation applies in an average sense to the population as a whole. We also include a recommendation concerning the upper limit of exposure that any one individual should receive.

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We ought to keep all of our expenditures of radiation as low as possible. Of the upper limit of 10 roentgens suggested in recommendation C, we are at present spending about one-third for medical X-rays. We are at present spending less, probably under one-half a roentgen, for weapons testing. We may find it desirable or even almost obligatory that we spend a certain amount on atomic powerplants. But we must watch and guard all our expenditures. From the point of view of genetics, they are all bad.

NUCLEAR DANGERS—TO THE INDIVIDUAL AND TO THE RACE

By Edward Teller and Albert L. Latter [5]

* * * On the average, human bones are getting about 0.002 roentgen per year from the Sr–90 [Strontium–90] in the fallout. In addition, the whole body is receiving a roughly equal amount in gamma rays, mainly from Cs–137 [Cesium–137]. These figures apply to new bone in young children who have grown up in an environment of Sr–90 in the northern part of the United States. This is a region of maximum fallout. Adults whose bones were made for the most part before the atomic testing started are getting about 0.0003 roentgen per year from Sr–90. None of these figures appear to be alarming.

At this present rate, a lifetime dosage in northern United States is only a small fraction of a roentgen. A rare individual might get several times this amount. If tests continue at the present rate, radiation levels could increase by as much as fivefold. However, even in this situation, it is difficult to imagine anyone receiving a lifetime dose of more than 5 or 10 roentgens from the worldwide fallout. A

[5] From Our Nuclear Future. New York, Criterion Books, Inc., 1958, pp. 118–124, 126–127, 129, 130.

more reasonable estimate for the average lifetime dose would be a few roentgens or less.

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It is possible that radiation of less than a certain intensity does not cause bone cancer or leukemia at all. In the past small doses of radiation have often been regarded as beneficial. This was not supported by any scientific evidence. Today many well-informed people believe that radiation is harmful even in the smallest amounts. This statement has been repeated in an authoritative manner. Actually, there can be little doubt that radiation hurts the individual cell. But a living being is a most complex thing. Damage to a small fraction of the cells might be beneficial to the whole organism. Some experiments on mice seem to show that exposure to a little radiation increases the life expectancy of the animals. Scientific truth is firm—when it is complete. The evidence of what a little radiation will do to a complex animal like a human being is in an early and uncertain state.

In any event, the number of additional cases of leukemia and bone cancer due to the fallout radiation is certainly too small to be noticed against the natural incidence of these disorders.

In the next 30 years about 6 million people throughout the world will die from leukemia and bone cancer. From past tests, which have involved the explosion of about 50 megatons of fission energy, the possibility exists that another 50 times 200, i. e., 10,000 cases, may occur. Statistical methods are not able to find the difference between 6,000,000 and 6,010,000. There is no way to differentiate between the fallout-induced cases of leukemia and bone cancer and those which occur naturally.

The possible shortening of 10,000 lives may seem rather ominous. But mere figures can be misleading. A better way to appreciate the danger from fallout is to compare it with other more familiar dangers.

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* * * fallout radiation is * * * only a few percent of the natural cosmic radiation. It is small even when compared to the variation of cosmic ray intensity between sea level and 5,000 feet.

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The background radiation to which we are exposed varies for some unexpected reasons. It has been pointed out recently that brick may contain more natural radioactivity than wood. The difference between living in a brick house and living in a wood house could give rise to 10 times as much radiation as we are currently getting from fallout. (The additional radiation from the brick might be as much as 0.03 roentgen per year.)

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We may summarize in this way: Our knowledge of the effects from the fallout is deficient. We cannot say exactly how many lives may be impaired or shortened. On the other hand, our knowledge is sufficient to state that the fallout effect is below the statistically observable limit. It is also considerably less than the effect produced by moving from sea level to an elevated location like Denver, where cosmic radiation has a greater intensity. It is also less than having a chest X-ray every year. In other words, we know enough to state positively that the danger from the worldwide fallout is less than many other radia-

tion effects which have not worried people and do not worry them now.

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The objection may be raised that the fallout, while not yet dangerous, may become so as more nations develop and test atomic weapons. On this point we can only say that the future is not easy to predict. Some factors, however, justify optimism. We are learning how to regulate the fallout by exploding bombs under proper surroundings. Development of clean bombs will greatly reduce the radioactivity produced. Deep underground tests will eliminate fallout altogether. The activity put into the atmosphere in 1954 was considerably greater than the activity released in any other year. It is highly probable that the activity produced by United States tests will continue to decline.

Finally, we may remark that radiation is unspecific in its effects. Chemicals are specific. About the effects of a new ingredient in our diet, in our medicine, or in the air we breathe, we know much less than we know about radiation. If we should worry about our ignorance concerning our chemical surroundings as we worry about the possible effects of radiation, we would be condemned to a conservatism that would stop all change and stifle all progress. Such conservatism would be more immobile than the empire of the Pharaohs.

It has been claimed that it is wrong to endanger any human life. Is it not more realistic and in fact more in keeping with the ideals of humanitarianism to strive toward a better life for all mankind?

* * * * * * *

Radiation may hurt the individual. It may also be harmful for our children and hurt the race. We have seen that the danger from the radiation due to testing is small compared to many risks which we habitually take and almost always ignore, which in fact we have to ignore to continue to live in this civilized world. In addition, we are not even quite sure that the danger to the individual is real.

There can be little doubt, however, that radiation does produce some harmful changes in our children. What seems even more frightening, is that these changes may not show up in our children but only in their children or further progeny. A danger which may lie hidden for generations might seem more terrifying, especially as it has often been repeated that all such radiation effects are harmful.

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Radiation is surely disruptive. It does cause mutations. Since the genes appear to be single molecules, a single process of ionization or excitation is likely to result in a change. As has been said before there is doubt whether or not cancer and leukemia can be caused by exceedingly little radiation. There is little doubt, however, that mutations can be caused by any small amount of radiation. The less radiation the less the chance. But the chance will always be there.

A very great increase in the natural rate of mutations could indeed have terrifying effects. We can be quite certain, however, that radiation from atomic tests will increase the chance of mutations by only a very small amount.

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The atomic tests are therefore increasing the number of mutations by about $0.05 \div 50$, which is 0.1 percent. This kind of increase in the

rate of mutations would certainly not seem to be a serious reason for worry.

Actually the number of mutations from the tests is very small even compared to geographical and altitude variations in the natural radioactivity. The Inca Empire existed for many generations in the high country of Peru. The people of Tibet have been exposed for generation after generation to the greater cosmic-ray intensity which bombards them through a thinner layer of atmosphere. These people have been exposed to much greater additional radiation than anything which is caused by atomic tests. Yet genetic differences have not been noticed in the human race or for that matter in any other living species in Peru or Tibet. We are certainly talking here about questions which may strike hard on some individuals but which from the point of view of the community or race are not serious.

It has been often repeated that all mutations due to radiation are harmful. There is every reason to believe that mutations due to radiation are not different in kind from other mutations. Should we then seriously believe that all mutations are harmful? That most of them are is admitted. If all of them were indeed always harmful, we must deny the simplest facts of evolution.

HOW DANGEROUS IS RADIOACTIVE FALLOUT?

By Willard F. Libby [6]

The United States Atomic Energy Commission, in line with its responsibilities for protecting the public health and safety, has engaged in an intensive effort to determine the facts on radioactive fallout and make them public. Its only purpose is to present the facts—and all the facts—which are based on sound scientific study judgment.

This effort has included the collection of several hundred thousand samples of dust and thousands of samples of soil, water, plants, foods and specimens of bone, both in this country and at other locations around the world. Not only the land and the oceans, but also the stratosphere, have been sampled for radioactivity.

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Without going into technical detail, important facts on fallout include the following:

THREE KINDS OF FALLOUT

1. Generally speaking, there are three kinds of radioactive fallout: local, tropospheric, and stratospheric. Local fallout can produce high levels of radioactivity in relatively localized areas downwind from a nuclear explosion. That is why controlled areas are established around the test sites. Local fallout does not contribute to worldwide radioactivity.

Tropospheric fallout comes from the troposphere—the lower part of the atmosphere. It is deposited in a band around the earth at the same general latitudes as the test sites, and descends to the earth's surface in a few weeks, or a month or so. Stratospheric fallout comes from tiny radioactive particles carried into the stratosphere after

[6] From How Dangerous Is Radioactive Fallout? Foreign policy bulletin, June 15, 1957, pp. 148–151. Dr Libby has been a member of the Atomic Energy Commission since 1954, and from 1950–54 was a member of its General Advisory Commission.

large nuclear detonations. It descends fairly uniformly over the earth's surface over a period of years.

2. Local fallout is insignificant unless the fireball of the detonation touches or closely approaches the earth's surface. It can be produced by small or large detonations, depending upon the height of the burst and the weather conditions at the time. Kiloton detonations—those equivalent to thousands but not millions of tons of TNT in energy release—produce tropospheric fallout, but usually do not push radioactive particles into the stratosphere. Stratospheric fallout results from the largest explosions; those equivalent to millions of tons of TNT.

3. The method of occurrence of worldwide distribution of fallout radioactivity is as follows: a gradual sifting down of low-level radioactivity from the stratosphere occurs fairly uniformly throughout the world. Most of the original radioactivity has decayed by the time the particles reach the ground, but some long-lived radioactive materials remain, and these are of the greatest importance in evaluating the effects of this fallout.

A band of somewhat higher radioactivity circles the earth in the same latitudes as the test sites, due to tropospheric fallout.

POSSIBLE HAZARDS

4. There are two possible hazards from this worldwide distribution of low-level radioactivity. The first is a possible hazard due to irradiation by penetrating gamma radiation from fallout materials outside the body. This hazard may be either genetic, due to irradiation of the reproductive organs, or to health, due to whole body effects. The second is a possible hazard to health due to the irradiation of the bones by radioactive strontium taken up in food and deposited in the skeleton. These two effects should not be confused; strontium does not appreciably irradiate the reproductive organs.

5. The magnitude of each of these effects is dependent upon the amount of radiation exposure. All of the information available to the Commission indicates that fallout radiation exposures at the present rate of testing are far too small to result in observable effects among the population.

Let me amplify this last point. The conclusion that the risk is very small—and it is a conclusion reached not only by scientists working directly on fallout studies, but also by authoritative groups such as the National Academy of Sciences and the British Medical Research Council—has two general bases.

The first of these is that the radiation dosages from fallout are extremely small compared with the permissible amount of radiation exposure recommended for the public by the most authoritative bodies—the United States National Committee on Radiation Protection, the International Commission on Radiological Protection, the National Academy of Sciences, and the British Medical Research Council. The permissible exposures for the public are one-tenth of those recommended for atomic-energy workers, and the latter are believed to be considerably smaller than exposures which would produce detectable effects.

The present concentration of radioactive strontium in newly formed bones, such as those of children, in the United States today is less than one-hundredth of the permissible level recommended for the public. The strontium concentration in adult bones is several times smaller. (Concentrations in persons elsewhere in the world are generally smaller than those in the United States.)

The external dosages from fallout, that is, those which might cause genetic effects, have averaged between 1 and five-thousandths of 1 roentgen per year in the United States during the last 3 or 4 years. This compares with a permissible dosage of 10 roentgens in 30 years for whole populations recommended by the National Academy of Sciences.

The second basis for the conclusion that the risk is slight is that the radiation dosages from fallout are extremely small compared with the radiation exposures which living things always have received from the natural radiation "background."

RADIATION ALL AROUND US

Background radiation is composed of cosmic rays from outer space and radiation from naturally radioactive materials in the soil, air, water, plants and animals, and in our own bodies. We all carry in our bodies and have in our surroundings amounts of natural radioactivity very much larger than those derived from radioactive fallout.

The natural radiation background varies considerably from place to place. It increases with altitude, because of increased cosmic-ray intensity. Above-normal background radiation also occurs in localities of uranium or thorium mineralization. Thus, persons increase their exposure to natural radiation by moving to a higher altitude, or going from an area of sedimentary rock formation to one of granite rock.

The additional radiation dosages which persons are receiving from test fallout are small compared with natural background dosages, and even compared with the variations in natural dosages from locality to locality.

We do not know of any bad effects of natural radiation exposure upon populations living in areas of above-normal background, although this question should be given further study. At any rate, if such effects exist, they are too small to be readily detected. Any effects from test fallout are far smaller.

As stated above, the external radiation dosages from fallout—those of genetic concern—have averaged between one and five thousandths of 1 roentgen annually. These figures should be compared with a normal background dosage of about one hundred and fifty thousandths of 1 roentgen annually. In other words, the external fallout radiation has been from 0.7 percent to about 3 percent of the natural radiation exposure.

In certain parts of the world, brick or concrete-block houses may contain enough natural radioactive material to expose persons living in them to more radiation than persons who live in wooden houses. These additional dosages may range from forty-thousandths to one-hundred-thousandths of a roentgen—8 to 100 times the dosages from test fallout.

RADIUM DIAL COMPARISON MADE

To take another common type of slight radiation exposure, a radium-dial wristwatch may give up to forty-thousandths of a roentgen annually to the sex organs. This is 8 to 40 times the fallout dosage.

The irradiation of bone by radioactive strontium, taken into the body with food, is small compared with the irradiation of bone by the penetrating cosmic rays from space.

In the United States persons living at sea level receive about thirty-seven-thousandths of a roentgen annually from cosmic rays, and persons at an altitude of 5,000 feet receive about sixty-thousandths of a roentgen annually. In comparison, in these latitudes, the average exposure of newly formed bones in the United States from radioactive strontium is about one and one-half thousandths of a roentgen—about one-sixteenth of the additional cosmic ray exposure at an altitude of 5,000 feet.

Expressed in another way, the additional irradiation of bone from radioactive strontium is about equal to that which the bones of a person at sea level would receive from cosmic rays if he moved from the beach to the top of a hill a few hundred feet high.

EFFECTS ON FOOD

Foods grown on calcium-deficient soil will have a higher strontium content than average. Also, some persons living in a given locality may assimilate more strontium than others. Therefore, variations from the average should be considered. Detailed studies of this question indicate that about 1 individual in 300 will have more than twice the average strontium concentration for a given locality, and that about 1 in several million will have 3 times the average value. In areas of calcium-deficient soils, persons might accumulate a maximum of five times the normal strontium concentrations.

What about future testing? If tests were to continue until 1983 at the rate of the last 5 years, levels in the United States would be expected to reach about 4 times their present values, and levels about 6 times the present ones would be reached by the year 2011 if tests were to continue for that long. These levels still would be small compared to natural radiation exposure.

I believe these figures show that nuclear tests have constituted a very small risk. Populations may expose themselves to much larger additional amounts of radiation by living in one locality rather than in another, and these additional amounts of natural radiation dosage have not produced any readily detectable effects.

Certainly the risk involved in many of our normal activities is much greater than the hazard from fallout.

WEIGHING TWO RISKS

I do not mean that there is no risk at all. What is important for every one to realize is that there is some risk, but that the risk is very small compared to many other risks which we accept voluntarily, or which are an inevitable part of life.

This small risk must be weighed against the risk which we in the United States, as well as persons throughout the free world, would take if nuclear weapons tests were to be abandoned before some safe-

guarded system of international disarmament is achieved. Tests are necessary if we are not to fall behind in nuclear weapons development.

This country is continuing to strive for the attainment of a sound disarmament system, and we should all pray that these efforts will succeed. Until that time, I believe the risk involved in nuclear tests is small indeed, compared with the terrible future we might face if we fell behind in our nuclear defense effort.

DETERMINING NUCLEAR HAZARDS

By Warren Weaver [7]

Now, I would like just briefly to sum up the final conclusion insofar as one can reasonably make a conclusion.

If mankind is already sustaining something like 7.3 roentgens of radiation, and you propose to add to this only something of the order of one-tenth of a roentgen, is this something which should worry us? Is this something which should deter us from the testing of atomic weapons? Should we say that this is completely unimportant and harmless, or should we be disturbed about it?

Now, I wish to suggest to you that almost any one of these viewpoints can be independently sustained. It all depends on what kind of considerations impress one. Let me make this quite clear. Are you chiefly impressed by a relative number or by an absolute number? The relative increase in the risk due to the testing of atomic weapons is small. It is very small, and from that point of view a great many honest, sincere, reliable servants of our Government have judged it to be negligible and have so stated. I have no criticism of their sincerity and of their patriotism when they have said this is a completely negligible effect. I do think that it has been a little unfortunate for them to refer to this as harmless, because it is not harmless.

PERCENTAGE OF BABIES NOW BORN WITH GENETIC HANDICAPS

One can in fact reckon up, in various ways, what harm one does genetically to the entire world by the radiation that comes from the testing of atomic weapons, and let me cite just one such estimate. Of all of the babies that are born, something like 4 percent have some major handicap, either at birth or very soon after birth, of the type that is normally called by a doctor a congenital malformation, some serious mental defect, epilepsy, some defect in the anatomy of the child, some defect in hearing or in sight, some major defect—a little over 4 percent actually of all babies born do have such pitiful and substantial handicaps at birth.

One supposes that about half of this total is due to genetic causes. The other half is due to birth accidents and to various unfortunate circumstances during the period of gestation. But it is reasonable to assume that about half, in other words, about 2 percent of these, are genetic in origin. The presumption is, reverting to your earlier question, Senator, that this is part of the genetic burden which the

[7] From testimony before the Senate Committee on Foreign Relations Subcommittee on Disarmament. Hearings, pt. 12, January 16–17, 1957, Washington, D. C. Washington, D. C., U. S. Government Printing Office, 1957, pp. 1135–1154. Dr. Weaver is Chairman of the Committee on Genetic Effects of Atomic Radiation, National Academy of Sciences.

race just bears because of this inescapable radiation which is flooding us.

Now, if you propose to add to that number of babies, let's say, only 1 part in 5,000 more, many people will say, "Well, 1 divided by 5,000 is a very small fraction. If I am increasing the risk for my children by only 1 part in 5,000, I don't think I will worry very much about that, or that anybody else ought to."

DAMAGE TO THE RACE PROPORTIONATE TO RISE IN RADIOACTIVITY

But, you see, if you apply that factor to a very large number of births, it nevertheless turns out that a substantial number of additional babies are going to be handicapped. This figure actually reckons out, for the planet as a whole, something of the order of 6,000 of the babies that will be born to all the people now alive. "All of the people now alive" are really the people we are talking to today. If you consider all the babies that they are going to have, the fallout from the testing of atomic weapons will probably add about 6,000 additional handicapped babies to that number * * *. If this [the rate of testing] is increased, then this danger slowly picks up. The fact that it slowly picks up leads to a second sort of paradox which often makes it very difficult for people to understand each other in this field, and makes it easy for sincere people to disagree. The present question is, what really affects you, something that is going to happen to your children or something that is going to happen 50 generations from now?

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DISAGREEMENT AMONG GENETICISTS

Well, a good deal of their disagreement results from these two paradoxes that I have mentioned, the paradox of numbers and the paradox of time, whether you are influenced by a very small ratio or whether you are influenced by an absolute amount of harm, whether you are concerned with your immediate children or whether you are concerned with the long generations.

Now, I will come as near as I can to answering the central question. It is certainly true that the genetic danger from the fallout resulting from the testing of atomic weapons up to the present time has borne a very small relationship to the total amount of radiation danger that the race has been subjected to, a very small fraction.

Therefore, I can understand completely why those responsible for the defense of our country will say, "This is a danger which I think we have to run, this is a risk which I think we have to run."

But I do not think it is fair to the people of the United States or the people of the world to give them the impression that there is no danger involved in this, for there is.

But weigh that danger against other dangers. If you asked me as a single citizen whether I would choose the genetic risk from fallout rather than the risk from stopping testing, I would answer "Yes." I think we have to run the fallout risk at the present moment. But I do not think it is fair to anybody to say that fallout is harmless. It is not harmless.

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EFFECTS OF MULTIPLE EXPLOSIONS OF NUCLEAR WEAPONS

Senator HUMPHREY. Doctor, I wonder if you could elaborate for us on the following statement contained in the Report of the Biological Effects of Atomic Radiation. I quote from it:

> That a single thermonuclear weapon can cause severe radiation damage hundreds of miles beyond its area of immediate devastation is all too well known. That enough such weapons exploded in an all-out war might render the entire earth or large parts of it, uninhabitable is at least conceivable.
>
> The actual results would depend on the number, the types, and the location of the explosions that actually took place.

In view of that statement, can you say whether any attempt is being made to correlate the study of genetic and pathological effects of atomic radiation with the knowledge of weapons experts?

Mr. WEAVER. I think the major attempt to carry out such correlation—and I think it is a very considerable and very competent attempt—occurs through the Division of Biology and Medicine of the Atomic Energy Commission, which has been sensitive to this problem from the beginning, which has had men of high competence and, I think, men of complete integrity and patriotism associated with it.

The question as to whether you could explode enough atomic weapons to make large portions of the earth uninhabitable, this is, of course, in the first instance, a matter of pathology, not of genetics.

At the present moment one knows roughly the order of magnitude of the dose, of the radiation dose, that comes from the explosion of a single major megaton range thermonuclear weapon. This is of the general order of from two-thousandths of a roentgen to eight-thousandths of a roentgen. You will not be surprised that one has to state a range. It is almost surely less than eight-thousandths of a roentgen and may be as small as two-thousandths of a roentgen.

You can multiply that up, anyone can multiply that up, himself. It turns out that one would have to detonate something of the order of 500 to 2,000, depending on which of those 2 former figures are used, something between 500 and 2,000 such weapons to bring the radiation dose due to them up to the level of the natural background. Now, presumably, man would still go on surviving, even if the natural background were doubled. But he would certainly be under a major genetic handicap.

QUESTIONS AND ANSWERS ABOUT HYDROGEN BOMBS

By the National Committee for a Sane Nuclear Policy [8]

Question. What is one of the fundamental arguments against the testing of the hydrogen bombs and nuclear explosives?

Answer. The main point is a simple one. Whenever a nuclear bomb is exploded, dangerous radioactive poisons get into the atmosphere and circle the globe. There is no way of knowing how much will fall on any given place on earth. Nor is there any way of controlling the fallout even if we did know.

This means that a nuclear explosion affects all peoples and not merely the people of the nation which exploded the bomb. * * *

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[8] From The World's Peoples Have a Right To Demand No Contamination Without Representation—Questions and Answers for Americans About Hydrogen Bombs. Advertisement in New York Herald Tribune, March 24, 1958.

Question. Has any evidence been advanced by these [nonatomic states] countries that nuclear testing represents a hazard to their people?

Answer. Yes. Japan, for example, has presented evidence to show that detectable quantities of radioactive strontium has turned up in the populous Tokyo area. Japanese scientists estimate that if not another nuclear bomb is exploded, the additional fallout from past nuclear explosions that will continue to fall to earth will bring the rate up to levels far beyond reasonable estimates of safety.

Question. Is there any evidence of actual or potential contamination in the United States?

Answer. In February of this year a survey under the auspices of the United States Atomic Energy Commission revealed the amount of poisonous radioactive strontium now in the bones of adults has increased 33 percent over the 1955–56 level. There was a 50 percent increase in the bones of children. For children up to age 4, the increase was as high as 60 percent. These amounts are but a very small fraction of the total "permissible dose" of strontium. But the increase, percentagewise, is cause for concern, especially since it is not known with precision how much strontium the body can tolerate without harm.

Question. Why have the tests resulted in a greater increase in radioactive strontium in the bones of children?

Answer. The growth process in children makes heavy demands on the body to assimilate calcium. Since strontium is chemically similar to calcium, the growing body mistakes the strontium for calcium.

Question. Have there been any other official surveys which give proof of radioactive fallout?

Answer. Yes. In 1954, studies made for the Atomic Energy Commission definitely established the fact that farmlands in the Midwest and milk in the Nation showed traces of radioactive strontium.

Question. Did these figures indicate any real or imminent danger?

Answer. The figures show that the amount of poisonous radioactive strontium in our soil and milk were at that time (1954) well under what the Atomic Energy Commission believes to be the danger limits. But the radioactive materials in the air have multiplied since that time because of the many bombs that have been exploded—not only by the United States but by the Soviet Union and Great Britain.

Question. Exactly what is the danger now?

Answer. This is where the debate begins. Some scientists say that the body can absorb radioactive poison up to a certain point without ill effect. But the large majority of scientists who have spoken out on this question say it is dangerous to assume that there is such a thing as a "safe" dosage of radioactive strontium, especially for children. In any event, they believe that the health of our people—and the world's peoples—is too vital a matter to be left to guesswork. That is why they earnestly call upon all nations now testing nuclear explosives to suspend their testing until these questions can be scientifically answered. They point out, further, that as new scientific evidence on the effects of radiation comes in, it becomes necessary to lower the safety limits.

For example, only a few years ago it was generally believed that people could have X-ray examinations at frequent intervals without ill effects. But these estimates have been sharply revised in recent months. Today, the safety margin is known to be only a fraction of what it was believed to be 3 years ago.

We cannot afford to make the same wrong guesses about radioactive fallout that we did with X-rays. After the poisonous radioactive materials get into the air, there is no way of washing the sky. Indeed, a nuclear bomb explosion will have its fallout effects for many years after a bomb goes off.

Question. How long will the danger last?

Answer. Radioactive strontium, for example, loses its power very slowly. After 28 years, it still retains half its strength. Therefore, each nuclear explosion adds to the long-term killing power of the radioactive material in the air.

While it is correct to say that the radiation danger from a nuclear explosion is comparatively small at any given time, we must remember that it does its harm over a long period.

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Question. What about the clean bomb?

Answer. The use of the word "clean" to describe a hydrogen bomb is a moral outrage. There is nothing clean about a bomb that can incinerate millions of people at a time. The word "clean" is intended to describe a nuclear bomb that is supposed to be free of radioactive fallout. No such bomb now exists. Even its proponents admit that it may take years to produce it. But we can't afford that kind of time.

Three or four years from now we may be able to point to a stockpile with a lowered radioactive yield. But overhead the sky may have become a canopy of radioactive poisons. In any event, the absurdity of clean-bomb speculation becomes apparent when we reflect that the Soviet may have no interest in dropping clean bombs on its enemies.

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